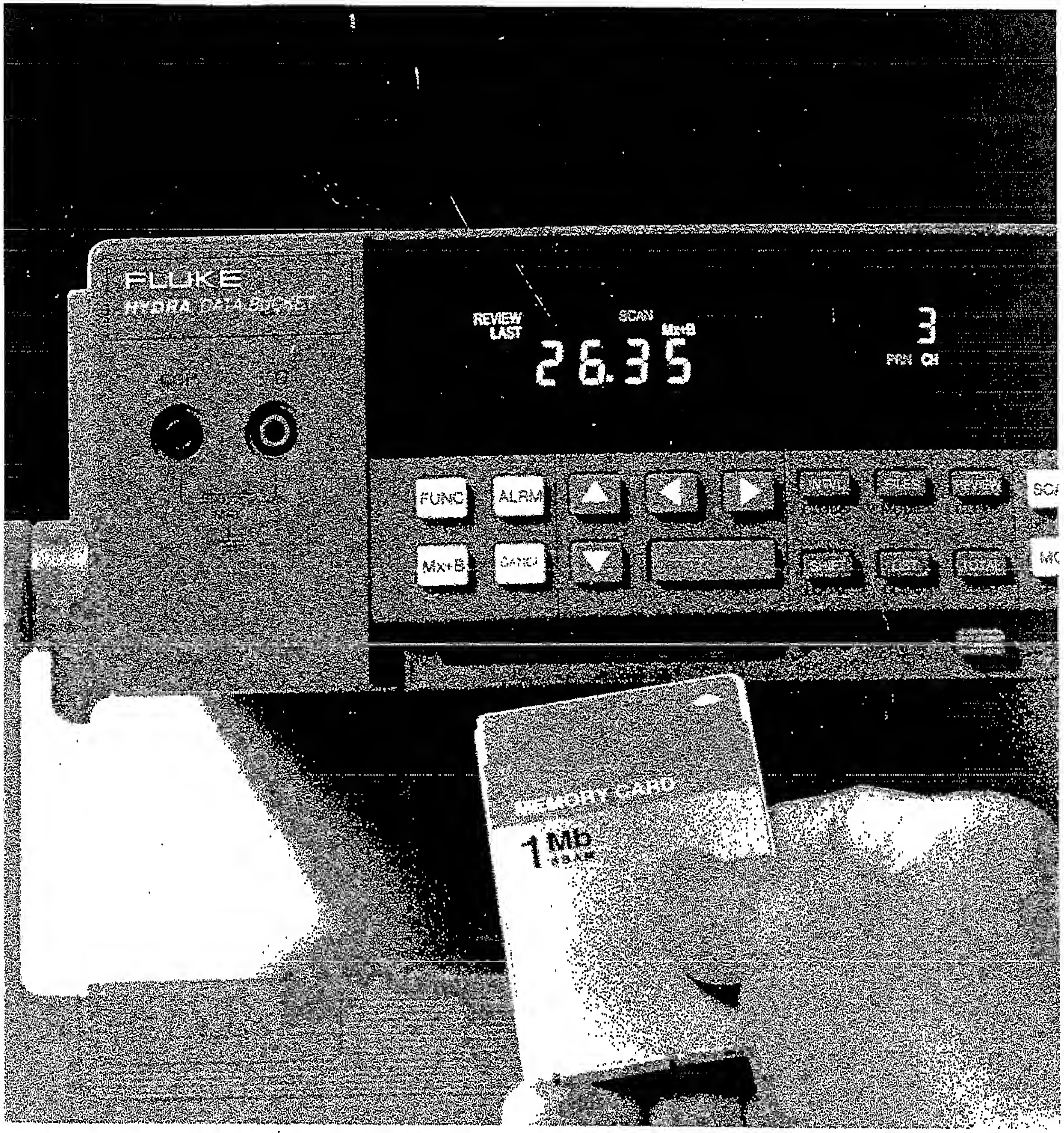

FLUKE
HYDRA DATA BUCKET
REVIEW
LAST
SCAN
Mx+B
26.35
3
PRN CH
FUNC
ALRM
Mx+B
MEMORY CARD
1 Mb

## DC POWER SOURCE

The instrument may also be operated from a 9 to 16V dc power source when either the rear panel ground binding post or the power cord grounding conductor is properly connected.

## USE THE PROPER FUSE

To avoid fire hazard, use only a fuse identical in type, voltage rating, and current rating as specified on the rear panel fuse rating label.

## GROUNDING THE INSTRUMENT

The instrument utilizes controlled overvoltage techniques that require the instrument to be grounded whenever normal mode or common mode ac voltages or transient voltages may occur. The enclosure must be grounded through the grounding conductor of the power cord, or if operated on battery with the power cord unplugged, through the rear panel ground binding post.

## USE THE PROPER POWER CORD

Use only the power cord and connector appropriate for the voltage and plug configuration in your country.

Use only a power cord that is in good condition.

Refer cord and connector changes to qualified service personnel.

## DO NOT OPERATE IN EXPLOSIVE ATMOSPHERES

To avoid explosion, do not operate the instrument in an atmosphere of explosive gas.

## DO NOT REMOVE COVER

To avoid personal injury or death, do not remove the instrument cover. Do not operate the instrument without the cover properly installed. Normal calibration is accomplished with the cover closed, and there are no user-serviceable parts inside the instrument, so there is no need for the operator to ever remove the cover. Access procedures and the warnings for such procedures are contained in the Service Manual. Service procedures are for qualified service personnel only.

## DO NOT ATTEMPT TO OPERATE IF PROTECTION MAY BE IMPAIRED

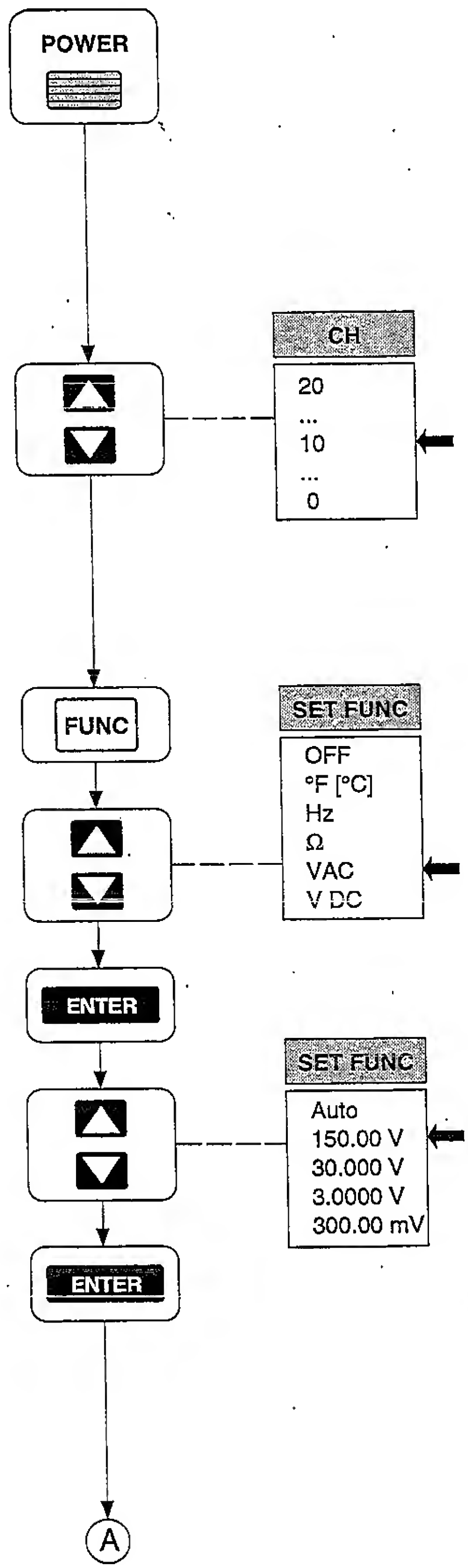
If the instrument appears damaged or operates abnormally, protection may be impaired. Do not attempt to operate it. When in doubt, have the instrument serviced.

# TABLE OF CONTENTS

| SECTION | TITLE | PAGE |
|---|---|---|

# LIST OF TABLES

# LIST OF ILLUSTRATIONS



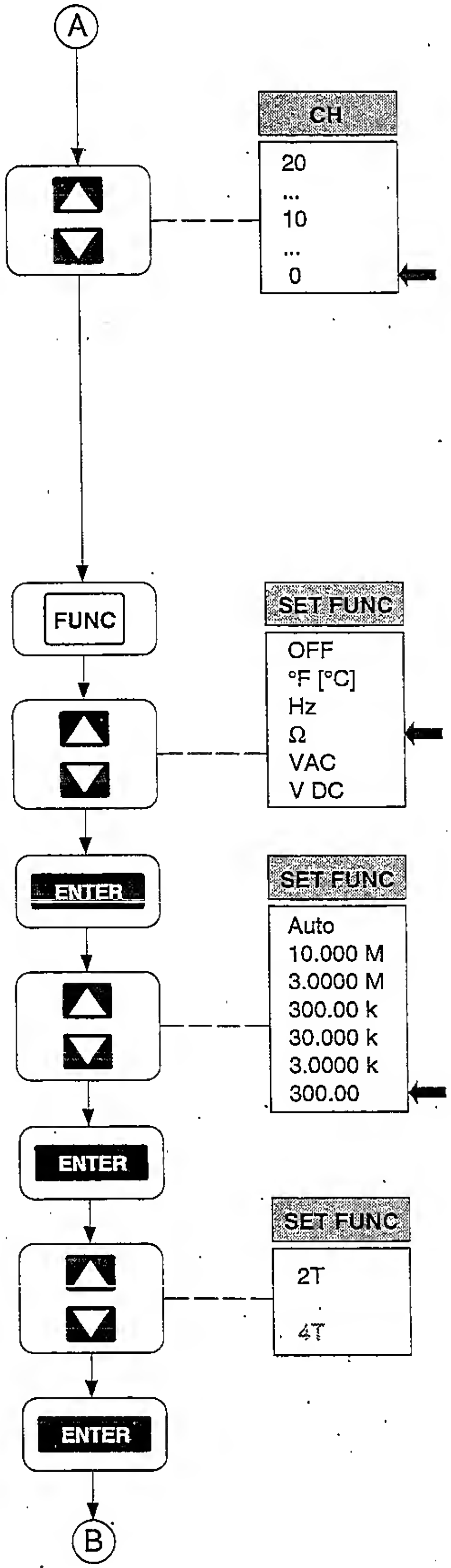

**Applying power.** Press the power switch to apply power. Other power-on options include Configuration-Reset, Display-Hold, and Temperature-Toggle. [Figure 2-2]

**Selecting a Channel.** Up/down arrow keys select a channel from 0 to 20. Channel 0 connections are on the front panel; Channels 1 through 20 connections are via the rear-panel Universal Input Module. Select Channel 10. [Figure 2-3]

**Selecting a Function.** Press the FUNC key to open the function menu. Up/down arrow keys select a function. Temperature unit °F/°C is set with the Temperature-Toggle Power-On procedure. Select VAC, then press ENTER. [Figure 2-5]

**Selecting a Measurement Scale.** Up/down arrow keys select a measurement scale. AUTO indicates autoranging, where the instrument automatically selects the scale that provides the best measurement resolution. Scale values are maximum expected readings, e.g., the 30.000 VAC scale is for measurements of 30 VAC or less. Select 150.00 V scale, then press ENTER. Channel 10 is now configured. [Figure 2-5]

Ten-Minute Tour



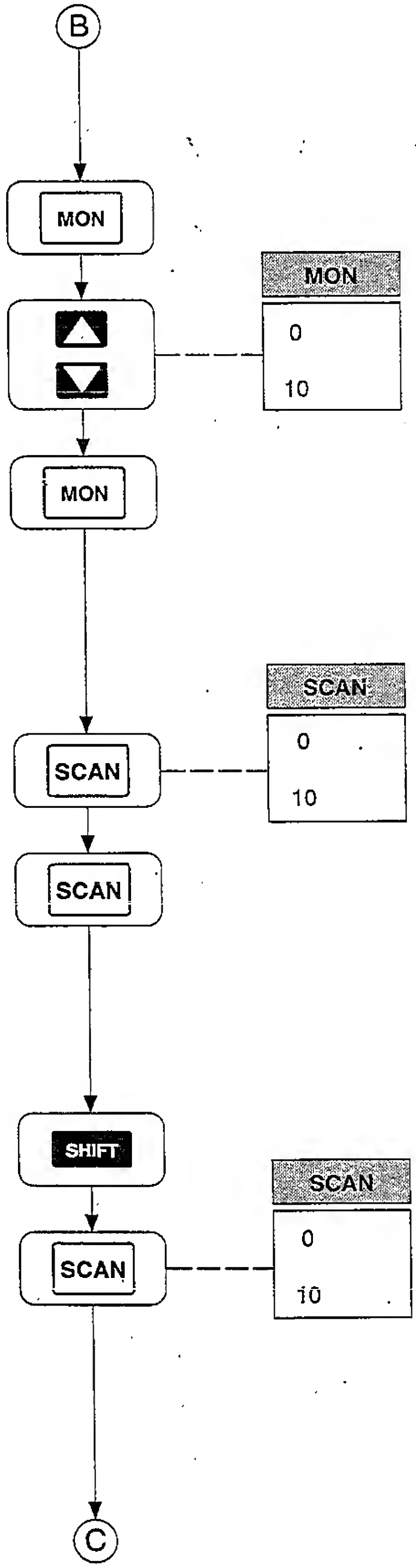

**Selecting a Channel.** Select Channel 0 with the up/down arrow keys. Notice each key entry is acknowledged with a short "beep." Try the left/right arrow keys and notice a long beep. Short beeps represent correct entries; long beeps represent incorrect entries. [Figure 2-3]

**Selecting a Function.** Press FUNC to open the function menu, use up/down arrow keys to select Ω, then press ENTER. [Figure 2-6]

**Selecting a Measurement Scale.** Select the 300.00 scale with up/down arrow keys, then press ENTER. [Figure 2-6]

**Selecting a Terminal Configuration.** Resistance measurements for channels 1 through 10 can use two channels (4 terminals) for increased precision. For channels 0 and 11 to 20, only 2 terminal (2T) connections are allowed. Press ENTER. [Figure 2-6]

**Ten-Minute Tour (Continued)**

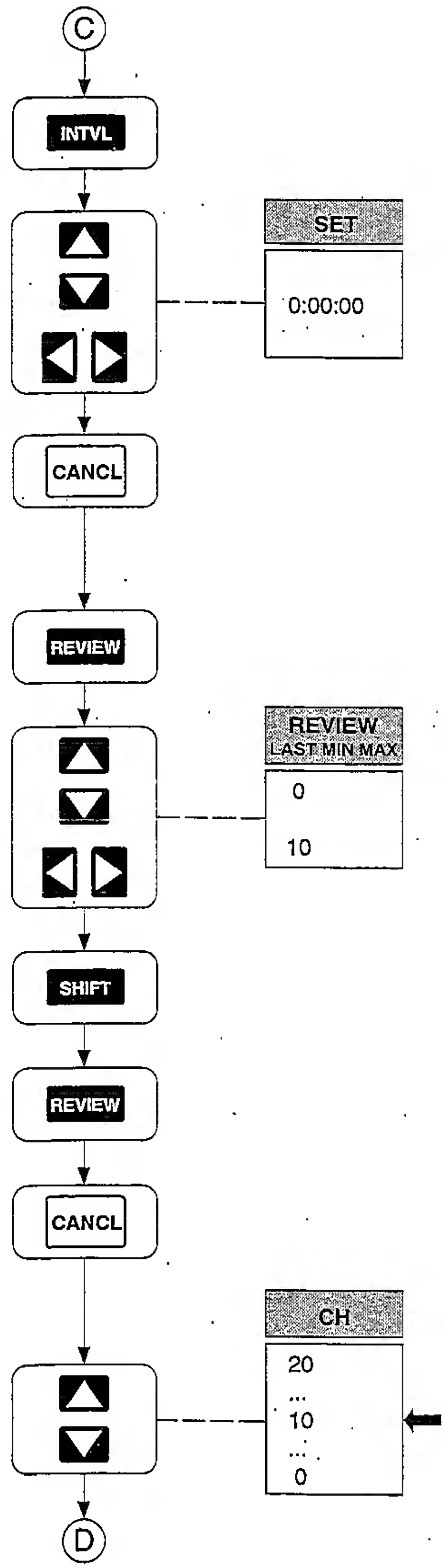



**Selecting the Monitor Mode.** Press the MON key to enable monitoring. Up/down arrow keys select any configured channel for monitoring. When Channel 0 (Ω) is selected, touch the probe tips together to measure test lead resistance. Channel 10 (VAC) may have a small reading because the input is unterminated. Press MON to exit monitoring. [Figure 2-17]

**Selecting the SCAN Mode.** Press the SCAN key to enable scanning. The display will indicate which channel is being measured during the scan. Monitor or Review can be enabled during scanning. Measurement data can be routed to the memory card, printer, or PC for display or processing. Press SCAN to exit scanning. [Figure 2-15]

**Selecting the Single Scan Mode.** Press the SHIFT key, release, then press the SCAN key to make a SINGLE measurement scan. [Figure 2-15]

Ten-Minute Tour (Continued)

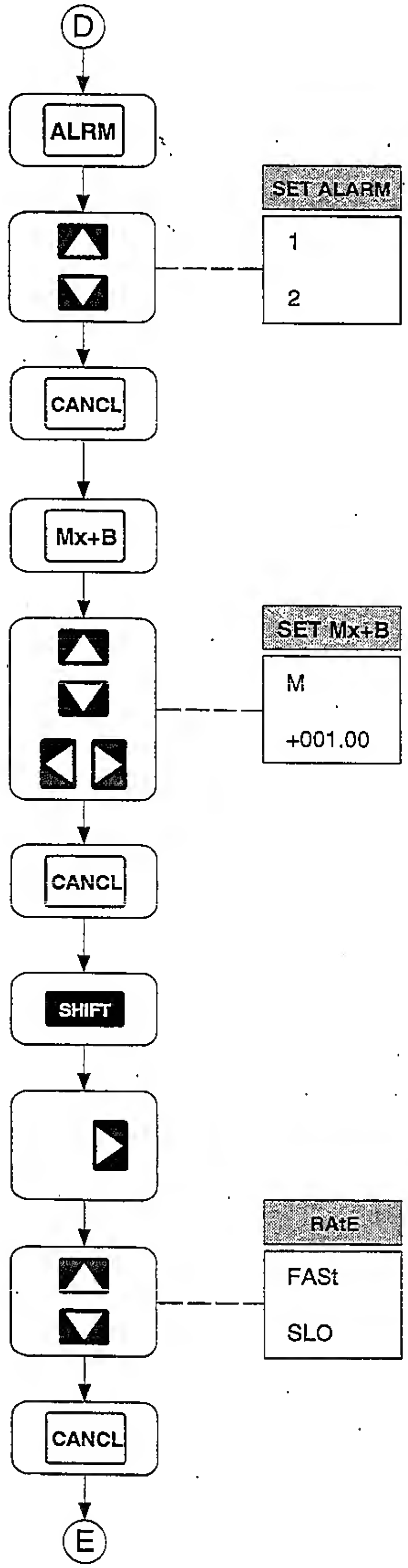



**Setting the Scan Interval.** Press the INTVL key to open the interval menu. Up/down and left/right arrow keys select 0:00:00 (default) to 9:99:99. The format is HOURS:MINUTES:SECONDS. The scan interval is the total time between the start of each measurement cycle. 0:00:00 represents continuous scanning. Press CANCL to exit. [Figure 2-11]

**Selecting the Review Mode.** Press the REVIEW key to open the Review array. The Review array holds the last, maximum, and minimum readings during all previous scans for all configured channels. Up/down arrow keys select the channel, while left/right arrow keys select LAST, MAX, and MIN. To CLEAR the Review array, press the SHIFT key, release, then press the REVIEW key. The Review array is cleared automatically by changing any parameter on any channel (including Measurement Rate). Press CANCL to exit. [Figure 2-18]

**Select Channel 10.** Select Channel 10 with the up/down arrow keys. [Figure 2-3]

**Ten-Minute Tour (Continued)**

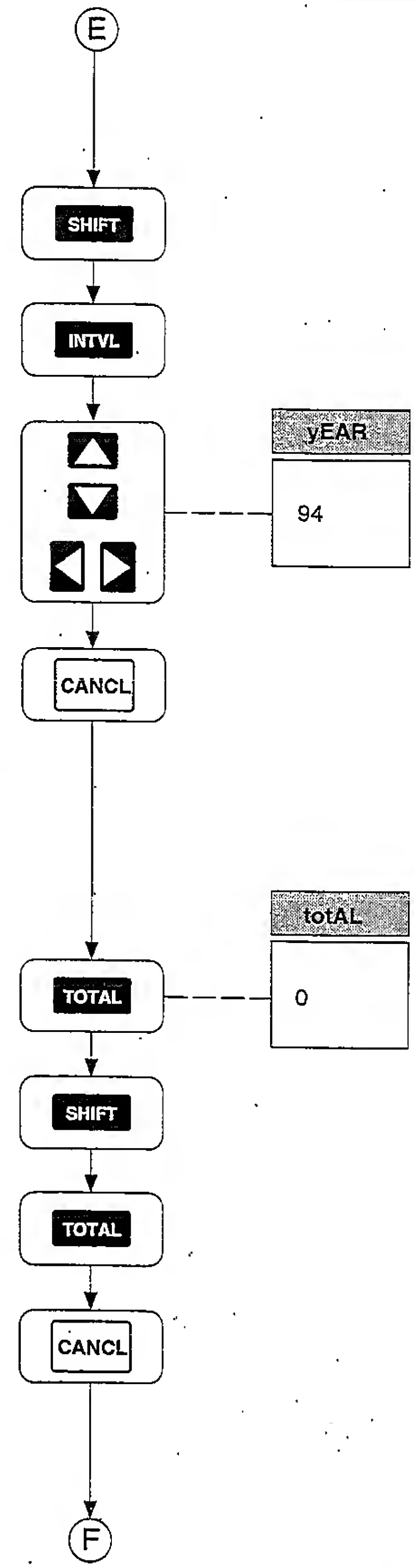



**Selecting Alarms.** Press the ALRM key to open the alarm menu. Each configured channel can have two alarm limits assigned. An alarm is set when a reading is below or above an alarm limit. Configuration starts with an alarm limit selection, 1 or 2. Press CANCL to exit. [Figure 2-13]

**Setting Mx+B Scaling.** Press the Mx+B key to open the Mx+B menu. Up/down and left/right arrow keys select the digits for the first parameter (M) (default +001.00). The effect of Mx+B scaling is to take a measurement (x) and modify it by multiplying the measurement with M and then adding an offset B (configured after M is set). For example, Mx+B=+1.5x+25 applied to a measurement of 20.000 would display 1.5(20.000) + 25 = 55.000. Press CANCL to exit. [Figure 2-14]

**Selecting the Measurement Rate.** Press the SHIFT key, release, then press the Right Arrow key to open the RATE menu. During the measurement portion of the scan interval, the measurement rate can be FASt (Fast) or SLO (Slow). The slow rate gives full 5-digit measurement resolution, while the fast rate gives only 4-digit resolution. The advantage of a fast measurement rate is more readings during continuous scanning or low scan intervals. Press CANCL to exit. [Figure 2-12]

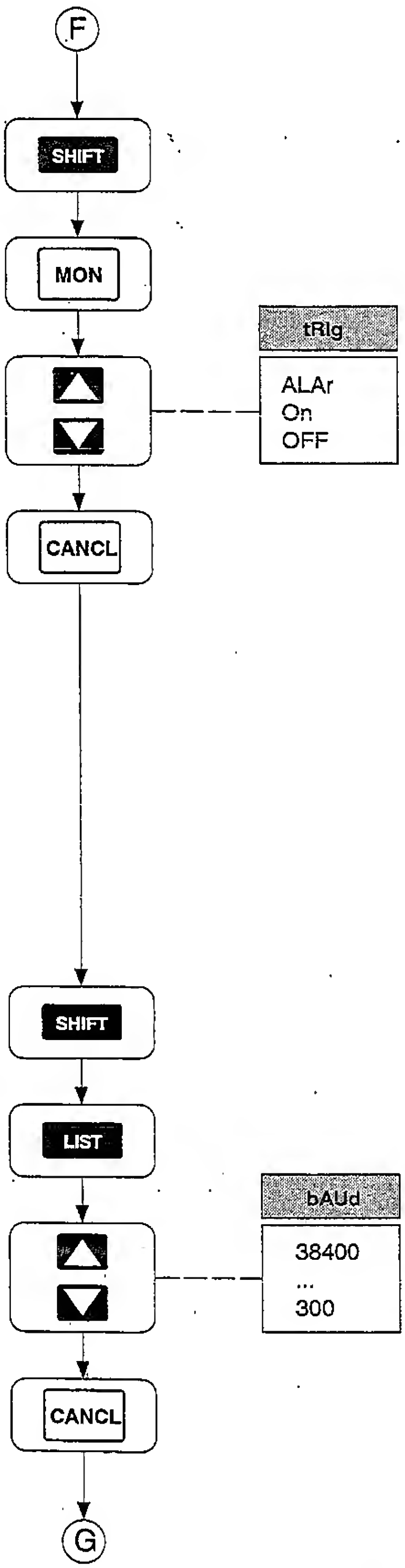
**Ten-Minute Tour (Continued)**




**Setting Date and Time.** Press the SHIFT key, release, then press the INTVL key to open the date and time (CLOCK) menu. Up/down and left/right arrow keys select the YEAR 00 to 99. For the complete procedure, this is followed by MONTH:DAY and HOURS:MINUTES. Press CANCL to exit. [Figure 2-21]

**Selecting the Totalizer Feature.** Press the TOTAL key to open the totalizer display. The totalizer operates independently as a separate instrument function. Contact closures or voltage transitions between pins $\Sigma$ and ⏚ on the rear panel DIGITAL I/O connector are totaled and displayed by pressing the TOTAL key. To ZERO the total (already 0 in this example), press the SHIFT key, release, then press the TOTAL key again. Press CANCL to exit. [Figure 2-20]

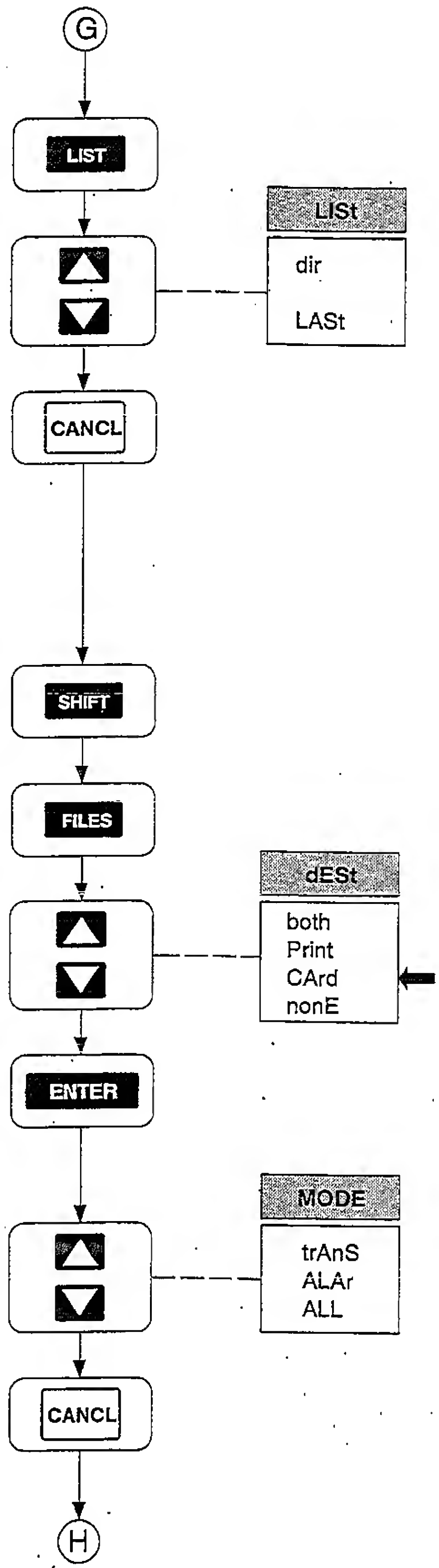
**Ten-Minute Tour (Continued)**




**Selecting Triggering Options.** Press the SHIFT key, release, then press the MON key to open the TRIGS option menu. A trigger option can trigger scanning, instead of using the SCAN key. OFF indicates no triggering option; ON indicates the external trigger option is active, (a contact closure or voltage transition between pins TR and ⏚ on the rear panel ALARM OUTPUTS connector); ALAr (Alarm) indicates scan triggering when a monitored channel goes into Alarm. Press CANCL to exit. [Figure 2-19]

**Setting the Communication Parameters.** Press the SHIFT key, release, then press the LIST key to open the COMM menu. The communication parameters configure the rear-panel RS-232 interface for printer and PC operations. The first selection is bAUd (Baud) with rates from 300 to 38400 baud. For the complete procedure, this is followed by parity, flow control and echo. Press CANCL to exit. [Figure 5-2]

**Ten-Minute Tour (Continued)**

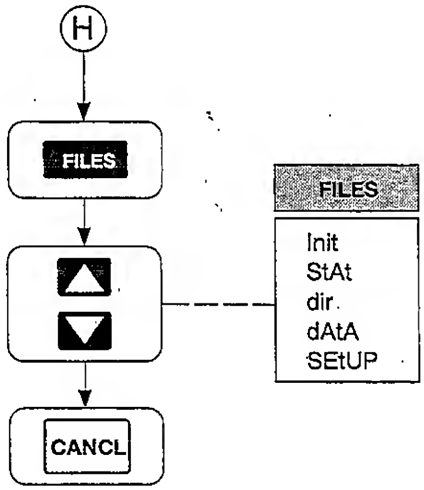



**Setting the LIST Parameters.** Press the LIST key to open the LIST menu. LIST is used to print out all the measurements from the Review Array, or print out a directory of all the files on the memory card by selecting dir (Directory). To use LIST, a printer (or PC) must be connected to the RS-232 port. Press CANCL to exit. [Figure 5-4]

**Setting the DESTINATION Parameter.** Press the SHIFT key, release, then press the FILES key to open the MODE menu. CArd (Card) routes data to the memory card; Print (Print) routes data to the RS-232 connector to a printer (or PC); both (Both) routes data to both destinations, and nonE (None) to neither destination. Select CArd and press ENTER. [Figure 5-3]

**Selecting the Destination Mode.** ALL (All) sends all measurement data to the destination device (Memory Card in this example); ALAr (Alarm) send all measurement data to the destination device when any scanned channel is in alarm; trAnS (Transition) sends all measurement data to the destination device when any scanned channel transitions into or out of an alarm condition. Press CANCL to exit. [Figure 5-3]

Ten-Minute Tour (Continued)




**Selecting the File Options.** Press the FILES key to open the Files menu. This menu selects the memory card functions. SEtUP (Setup) selects card functions for instrument configuration files (SEtxx); dAtA (Data) selects card functions for measurement data files (dAtxx); dir (Directory) lists the number of kilobytes free on the card and the name and size of each SEtxx and dAtxx file; StAt (Status) lists which SEtxx and dAtxx files are currently active and percentage of the card that is used; Init (Initialize) formats a blank card or erases and formats a used card. Press CANCL to exit. [Figure 3-3]

## Ten-Minute Tour (Continued)

# Section 1
# Preparation for Use

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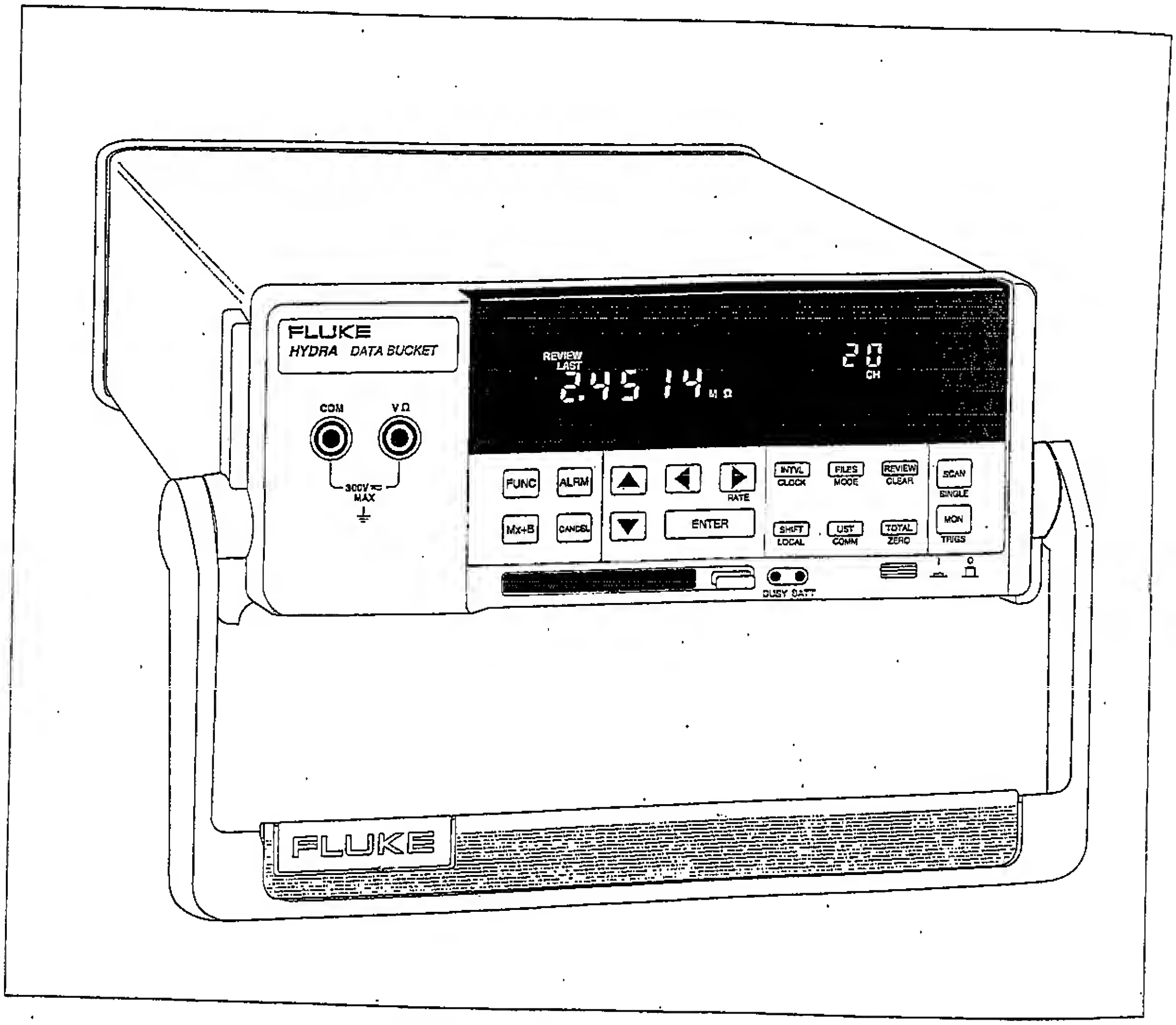
PAGE




**Hydra Model 2635A Data Bucket**

*NOTE*

*This manual contains information and warnings that must be followed to ensure safe operation and keep the instrument in safe condition.*

## INTRODUCTION 1-1.

The Fluke 2635A Hydra Data Bucket is a 21-channel data logging instrument that measures and records the following electrical and physical parameters: dc volts, ac volts, resistance, frequency, and temperature. Temperature measurements are via thermocouples or resistance-temperature detectors (RTDs). Other parameters can be measured with an appropriate transducer, such as air pressure/vacuum (using a Fluke PV350 or PV500 transducer module) or DC current (using a Fluke 80J-10 shunt resistor). When the instrument scans channels configured for measurement, readings can be displayed, printed out, and recorded. Virtually any analog input may be applied without external signal conditioning. The inputs for channels 1 through 20 are via a Universal Input Module, which plugs into the rear of the unit for a quick connect/disconnect capability. Channel 0 measurements are via the front panel input jacks using test leads (supplied). For a quick introduction to the operation of the instrument, complete the Ten-Minute Tour at the front of this manual. A summary of the Hydra Data Bucket features is provided in Table 1-1 and complete specifications in Appendix A. Figure 1-1 shows the instrument front and rear panels.

## OPERATING MODES 1-2.

The Data Bucket may be used in a wide variety of applications using one or more of five operating modes:

- Front Panel Operation
- Memory Card Operation
- Computer Operation
- Printer Operation
- Modem Operation

### Front Panel Operation 1-3.

Front panel operations include configuration of channels in preparation for scanning operations and simple multimeter operation by placing the instrument in the Monitor mode then using the front panel jacks and test leads (channel 0) for measurements. Front panel operations are discussed in Section 2.

### Memory Card Operation 1-4.

An adjunct to stand-alone front panel use are operations that use the memory card feature. The memory card is a Static Random Access Memory (SRAM) device that plugs into a slot on the Data Bucket front panel. An internal battery maintains the integrity of the stored data. An empty 256K-byte card stores 8500 scans of 4 channels, 4500 scans of 10 channels, or 2500 scans of 20 channels. A typical display while scanning using the memory card is shown in Figure 1-2. The PC-compatible memory card can be used to store measurement files and configuration files. Data extraction from the card requires a personal computer (PC), where data can be sent from the Data Bucket to the PC over an RS-232 link (up to a 38,400 baud rate), or the card can be removed and taken to a PC equipped with a memory card reader (see Options and Accessories). Memory card operations are discussed in Section 3.

### Table 1-1. Data Bucket Features

- Channel Scanning

  Can be continuous scanning, scanning at an interval time, single scans, or triggered (internal or external) scans. Channel Monitoring may be used while scanning.

- Channel Monitoring

  Make measurements on a single channel and view these measurements on the display.

- Memory Card

  Store measurement data and meter configuration setup data on a removable nonvolatile RAM card.

- Multi-Function Display

  Primary display shows measurement readings; also used when setting numeric parameters.

  Secondary display used for numeric entries, channel number selection and display, status information, and operator prompts.

  Annunciator display used to show measurement units, alarms, review parameters, remote status, and configuration information.

- Front-Panel Operation

  Almost all operations can be readily controlled with the front panel keys.

- Measurement Input Function and Range

  Volts dc (V DC), volts ac (VAC), frequency (Hz), and resistance (Ω) inputs can be specified i fixed measurement range. Autoranging, which allows the instrument to use the measureme... range providing the optimum resolution, can also be selected.

- Temperature Measurement

  Thermocouple types J, K, E, T, N, R, S, and B, and Hoskins Engineering Co. type C are supported. Also, DIN/IEC 751 Platinum RTDs are supported.

- Totalize Events on the Totalizing Input
- Alarm Limits and Digital Output Alarm Indication
- Four-Terminal Resistance Measurements (Channels 1 through 10 only)
- RS-232 Computer Interface Operation
- Measurement Rate Selection
- Nonvolatile Memory

  Storage of minimum, maximum, and most recent measurements for all scanned channels

  Storage of Computer Interface setup, channel configurations, and calibration values.

  Internal storage of measurement data: storage for 100 scans of up to 21 channels, accessible only through the computer interface.

## Computer Operation 1-5.

The Data Bucket can serve as a front-end data acquisition unit for PC-based operations, operating over an RS-232 link. The applications software for operating the RS-232 link includes the supplied Hydra Starter Package (Starter) and optional Hydra Data Logger (Logger) (see "Applications Software" below). Computer operations are discussed in Section 4.

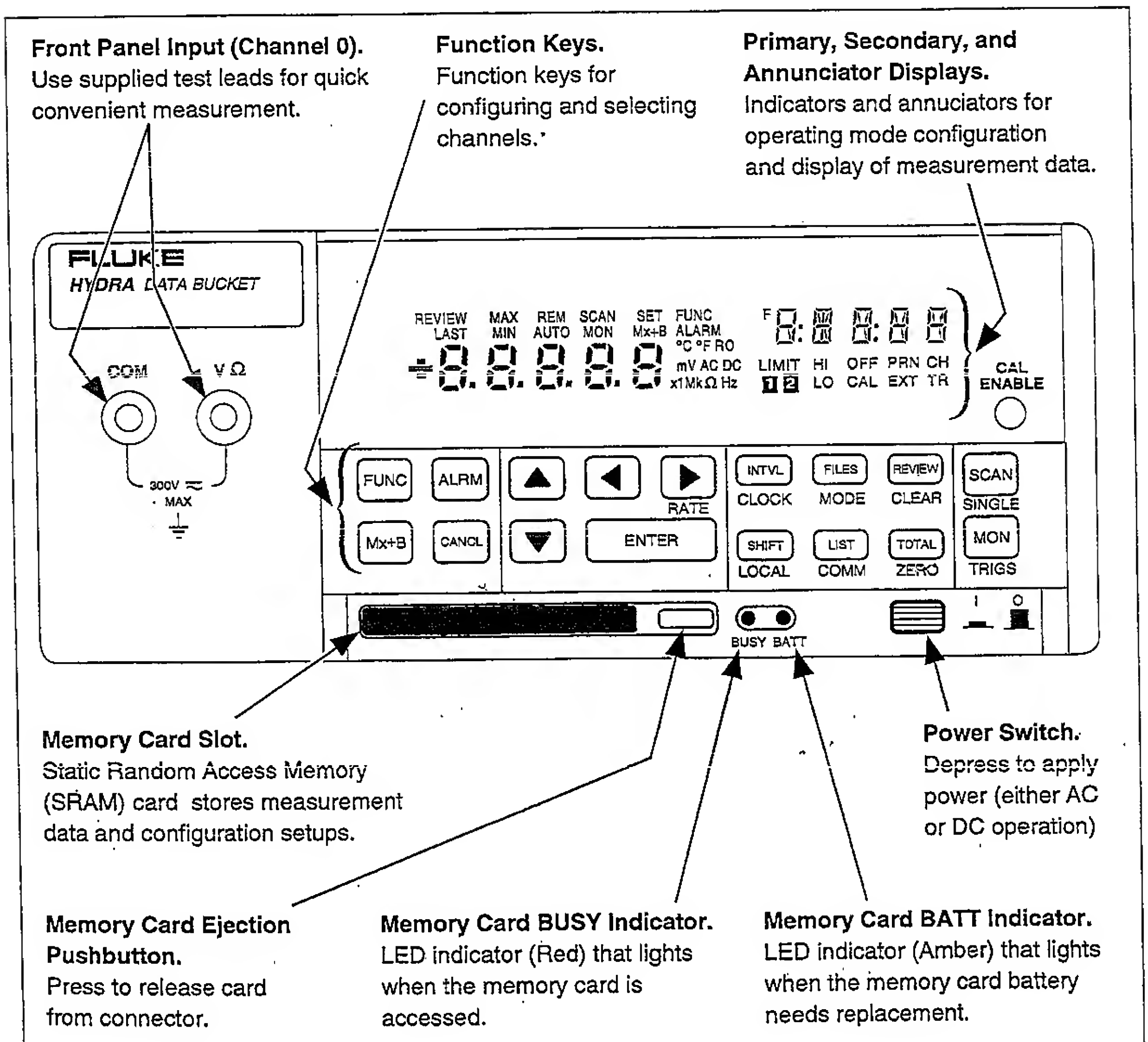



**Figure 1-1. Data Bucket Front and Rear Panels (Sheet 1 of 2)**

## Printer Operation 1-6.

Measurement data from the Data Bucket can be routed to a printer via an RS-232 link. At the completion of each scan cycle, measurement data is printed, providing hardcopy output. Any compatible printer with a serial input may be used (see Options and Accessories). Printers with a parallel input may be used if they are equipped with a serial-to-parallel adapter. Printer operations are discussed in Section 5.

## Modem Operation 1-7.

An RS-232 link between the Data Bucket and a modem allows data transfers over telephone lines. Operation is similar to computer operations, except there is a modem link instead of a direct RS-232 connection. The modem may be electronic or programmable/electronic (Hayes-compatible). Modem operations are discussed in Section 6.

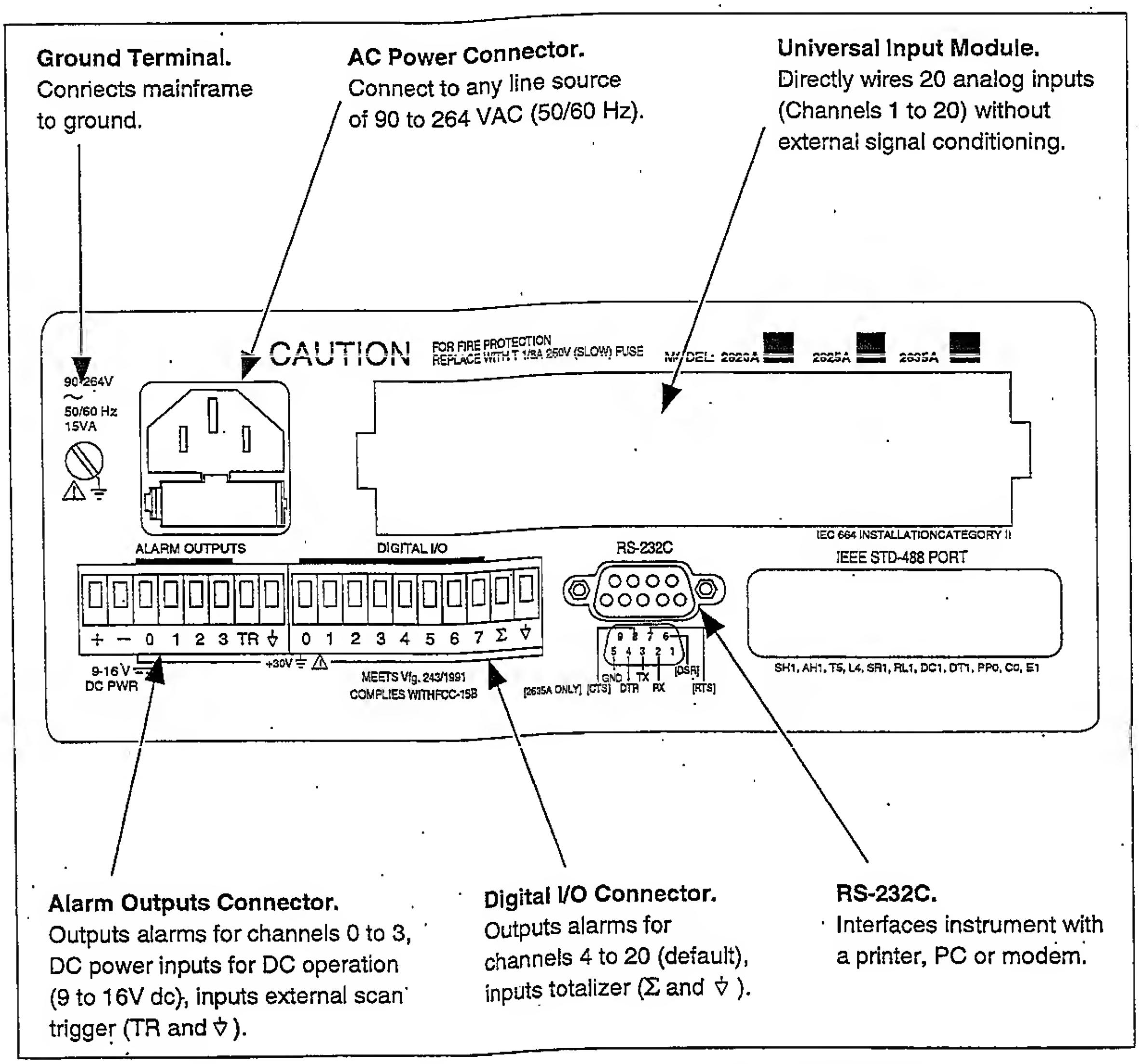



**Figure 1-1. Data Bucket Front and Rear Panels (Sheet 2 of 2)**

## MEASUREMENT CAPABILITIES 1-8.

Before scanning is enabled, the Data Bucket channels are configured for measuring the selected electrical or physical parameter (volts dc, volts ac, temperature, etc.). Readings have five digits of resolution, for example, 15.388 VAC. Scanning collects measurement data, while the monitor mode can monitor a channel with or without scanning. The review mode stores the maximum, minimum and last readings. Mx+B scaling and alarm attributes can be applied to each configured channel. A totalizer channel is supplied as a separate feature, and digital I/O functions are provided by the rear panel connectors, ALARM OUTPUTS, and DIGITAL I/O.

### Mx+B Scaling 1-9.

The Mx+B scaling attribute allows readings to be modified to better represent what is being measured. The M represents a multiplier and B represents an offset. For example, a normal reading of 3 volts can be multiplied by M=+100 and offset by B=-25, to display 275 (3x100 - 25= 275). Mx+B scaling can be applied to any configured channel. This feature is especially useful to scale transducer outputs for exact measurement displays.

### Alarms 1-10.

The alarms attribute allows readings that rise or fall below preset levels to alert the operator and trigger an action. For example, if you are monitoring temperature and want to have 100°C cause an alarm condition, this can be programmed as part of the channel configuration. Alarm conditions are reported as part of the measurement scan data and can be used to trigger scanning and assert a logic low on a rear panel ALARM OUTPUTS or DIGITAL I/O connector terminal for interface with external equipment. Two alarms can be assigned to any configured channel. If Mx+B scaling is applied, the alarms are based on the scaled values.

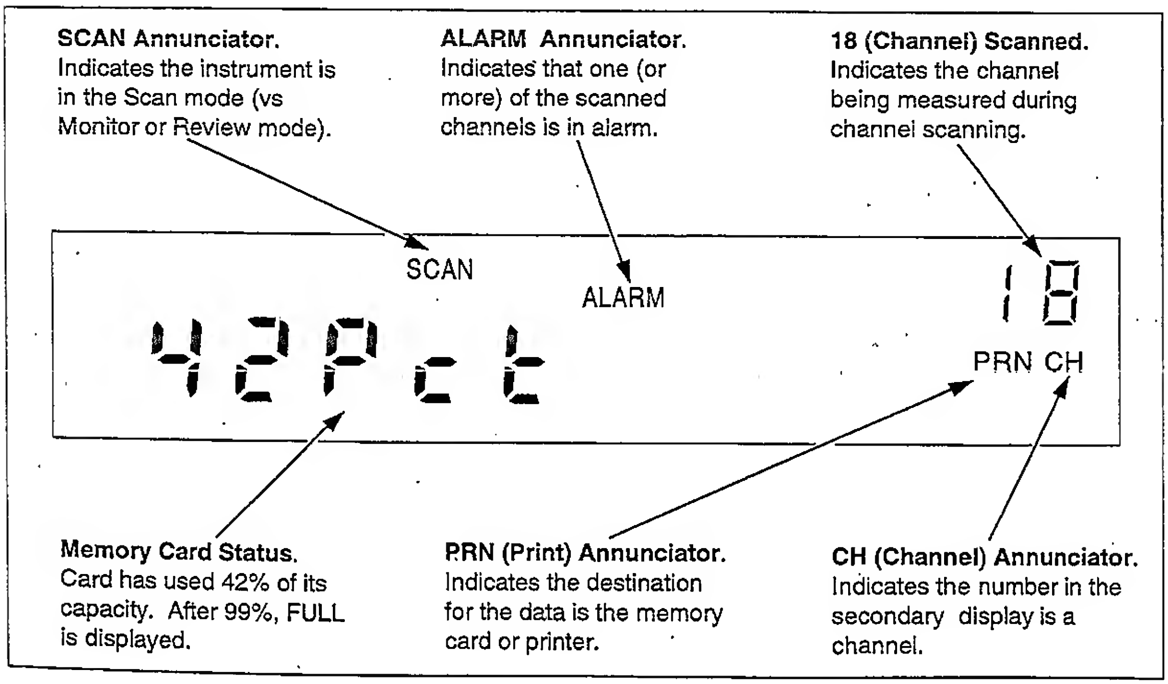



**Figure 1-2. Typical Front Panel Display While Scanning**

## Totalizer Channel 1-11.

The totalizer channel counts contact closures or voltage transitions. The maximum count is 65,535. The connection is at the rear panel ALARMS OUTPUTS connector, terminals $\Sigma$ and ' . The Data Bucket continuously samples the totalizer input on the rear panel, independently from Hydra's scanning and other activities.

## Alarm Outputs and Digital I/O 1-12.

Alarm outputs are available on the rear panel ALARM OUTPUTS and DIGITAL I/O connectors. The four ALARM OUTPUT lines are permanently assigned to signal alarms for channels 0, 1, 2, and 3. The eight DIGITAL I/O lines can be used to signal alarm conditions for channels 4 to 20. All input/output lines are transistor-transistor-logic (TTL) compatible. For operations that do not use a computer interface, these are the only functions of the ALARM OUTPUTS and DIGITAL I/O connections. When a computer interface is used, the DIGITAL I/O lines can be assigned in the applications software for a variety of inputs or outputs. The ALARM OUTPUTS can also be assigned for I/O operations if the dedicated alarm function is not used (which has priority).

## APPLICATIONS SOFTWARE 1-13.

PC applications software Hydra Starter Package (Starter) (supplied) and Hydra Data Logger Package (Logger) (optional) operate the the instrument via the RS-232 computer interface. The software packages are described in separate technical manuals; however, each is summarized below.

An extensive command set allows the user to develop custom software in GWBASIC, QBASIC, and QuickC. The command set is discussed in Section 4.

## Hydra Starter Package 1-14.

Starter is a menu-driven software package used to transfer configuration data from and to the instrument, log measurement data collected by the instrument, extract data from the memory card, and manage the acquired data. During operation, Starter displays readings of all channels in real time and can automatically log the data to a Lotus 1-2-3 compatible file.

## Hydra Logger Package 1-15.

Logger has all the features of Starter plus a trend plot display (with proper PC display capability), strip-chart printer plot (with graphics compatible printer), and the ability to operate two instruments at a time.

## OPTIONS AND ACCESSORIES 1-16.

Options and accessories include measurement transducers, cables, applications software, carrying case and other items, all of which are summarized in Table 1-2.

## Memory Card Reader 1-17.

Data Bucket measurement data and configuration setups may be stored on a memory card that is inserted into the slot on the instrument front panel (see Figure 1-1). To review and analyze the recorded data, the memory card data can be routed to a PC via the RS-232 interface, or the memory card can be removed and taken to a PC equipped with a memory card reader. The memory card reader (optional) is external to the PC and connects to a PC parallel port (LPT1, LPT2, etc.). The memory card reader is configured as another PC drive, e.g., the D: drive. Memory card files include data files (dAtxx.HYD) and configuration setups (SEtxx.HYD). The PC manipulates these files using applications software Starter (supplied) and Logger (Optional). The selected memory card reader must read SRAM cards and meet Personal Computer Memory Card International Association (PCMCIA)/Japan Electronics Industrial Development Association (JEIDA) standards. This memory card application meets PCMCIA standards release 2.0.

## Connector Set, 2620A-100 1-18.

The 2620A-100 is a complete set of input connectors: one Universal Input Module, one ALARM OUTPUTS connector, and one DIGITAL I/O connector. The use of additional connector sets allows quick equipment interface to several wiring setups.

**Table 1-2. Options and Accessories**

| MODEL | DESCRIPTION |
|---|---|
| 80i-410 | Clamp-On DC/AC Current Probe. |
| 80i-1010 | Clamp-On DC/AC Current Probe. |
| 80J-10 | Current Shunt. |
| 2620A-100 | I/O Connector Set: Includes Universal Input Module, Digital I/O and Alarm Output Connectors. |
| 26XXA-901 | Hydra Logger Applications Package (Version 3.0). |
| 262XA-801 | Diconix™ 80-column serial printer. |
| 263XA-803 | Memory Card Reader for IBM-PC or compatible personal computer. Card reader is external to the PC and connects to a PC parallel port (LPT1, LPT2, etc.). |
| 263XA-804 | 256K-Byte Memory Card (one card is supplied with Instrument). |
| 263XA-805 | 1M-Byte Memory Card. |
| 889589 | Service Manual. |
| C40 | Soft carrying case. Provides padded protection for the instrument. Includes a pocket for the manual and pouch for the line cord. |
| M00-200-634 | Rackmount Kit. Provides standard 19-inch rack mounting for one instrument (right or left side). |
| PM 8922 | Switchable x1, x10 passive probe. |
| RS40 | Shielded RS-232 modem interface cable. Connects the instrument to any terminal or printer with properly configured DTE connector (DB-25 pins), including an IBM PC™, IBM PC/XT™, or IBM PS/2™ (Models 25, 30, 50, P60, 70, and 80). |
| RS41 | Shielded RS-232 modem interface cable. Connects the instrument to a modem with properly configured DCE (DB-25 sockets) connector. Use an RS40 and an RS41 cable in series to connect with an IBM PC/AT™. |
| RS42 | Serial printer cable. Contact Fluke for list of compatible printers. |
| TL20 | Industrial test lead set. |
| TL70A | Test lead set (one set is supplied with Instrument). |
| Y9109 | Converts binding post connection to BNC connection. |
| Fluke PN 268789 | 10Ω Precision Resister, metal film, ± 1%, 1/8 watt, 100 ppm. For use with 4 - 40 mA signals. |

## SETTING UP THE INSTRUMENT 1-19.

Setting up the instrument includes all preparatory information, from unpacking the instrument to application of power.

### Unpacking and Inspecting the Instrument 1-20.

The following items are included in the shipping container:

- Model 2635A Data Bucket instrument
- This manual
- Starter Applications software (floppy disks and manual)
- Quick Reference Card
- Universal Input Module
- ALARM OUTPUTS and DIGITAL I/O connectors
- Channel 0 (front panel) TL70A test leads
- Line power cord
- Type "T" Thermocouple
- 256K-byte Memory Card

Carefully remove the instrument from its shipping container and inspect the instrument for possible damage or missing items. If the instrument is damaged or anything is missing, contact the place of purchase immediately. Save the container and packing material in case you have to return the instrument.

Rotate the rear feet of the instrument 180 degrees so that their support pads extend slightly below the bottom of the case.

### Adjusting the Handle 1-21.

The handle can be positioned to four angles: one for carrying, two for viewing, and one for handle removal. To change the angle, simultaneously pull both handle ends outward to hard stops (about 1/4-inch on each side) and then rotate the handle to one of the four stop positions shown in Figure 1-3. With the handle in the straight-up removal position, you can disengage and free one handle side at a time.

### Connecting the Instrument to a Power Source 1-22.

The instrument can be connected to an ac or dc source. Connections are shown in Figure 1-4 and described below.

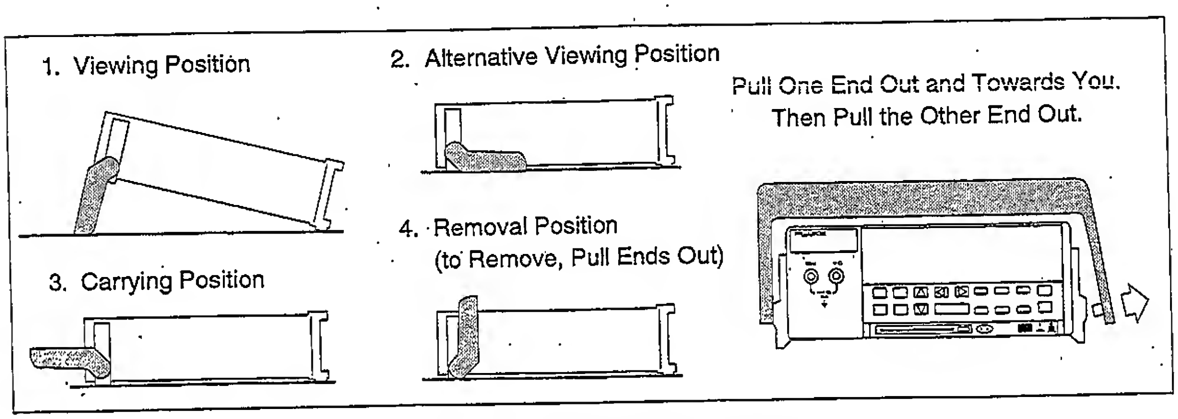



**Figure 1-3. Adjusting the Handle**

### WARNING

**TO AVOID SHOCK HAZARD, CONNECT THE INSTRUMENT POWER CORD TO A POWER RECEPTACLE WITH EARTH GROUND.**

## AC OPERATION

Plug the line cord into the connector on the rear of the instrument. The instrument operates on any line voltage between 90 and 264V ac without adjustment, and at any frequency between 45 and 440 Hz. However, the instrument is warranted to meet published specifications only at 50 or 60 Hz.

## DC OPERATION

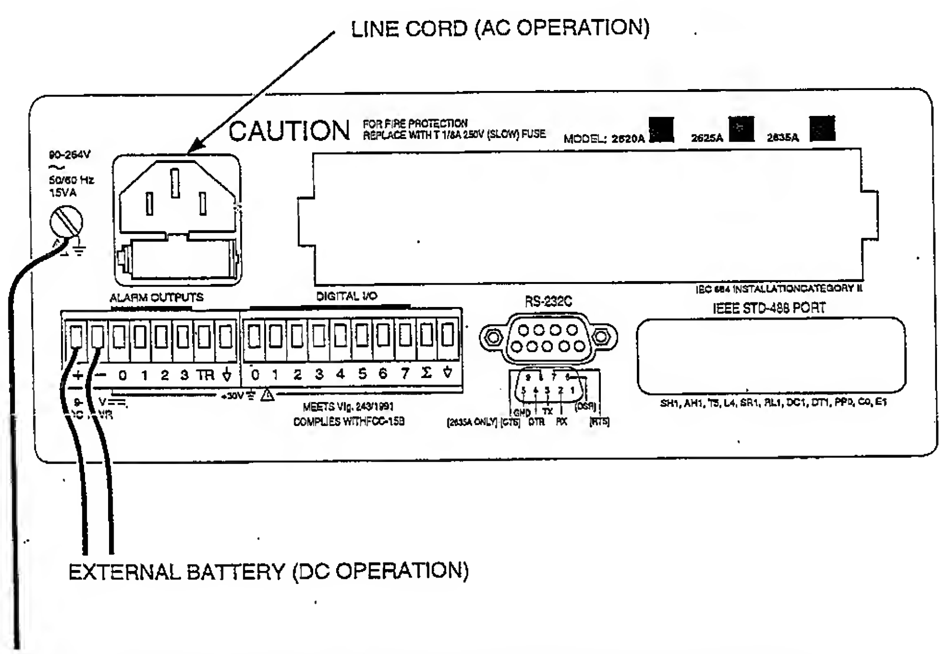
The instrument may be operated from a DC voltage between 9 and 16 volts, consuming a nominal 4 watts. Connection is made at the rear panel ALARM OUTPUTS connector, pins (+) and (-). If both ac and dc power sources are connected simultaneously, ac power is used if the voltage exceeds approximately 8.3 times the dc voltage. Automatic switchover occurs between ac and dc without interruption.

## Input Channels 1-23.

The instrument provides one input (channel 0) on the front panel and 20 inputs (channels 1 through 20) through a connector on the rear panel. Channels 0, 1, and 11 can measure a maximum of 300V dc or ac rms; all other channels can measure a maximum of 150V dc or ac rms.

### CAUTION

**DO NOT EXCEED THE SPECIFIED INPUT VOLTAGE LEVELS OR EQUIPMENT DAMAGE COULD RESULT.**




**WARNING:** If voltages greater than 50V are to be measured, a separate earth ground must be attached to this rear panel ground connector when the instrument is operated from battery power.

**Figure 1-4. Connecting the Instrument to a Power Source**

## MEASUREMENT CONNECTIONS 1-24.

Input connections include the front panel terminals (channel 0), rear panel connections using the Universal Input Module (channels 1 through 20), and I/O functions using the ALARM OUTPUTS and DIGITAL I/O connectors. The instrument is protected from channel configuration errors. For example, accidentally applying 300V ac to a channel configured for resistance measurements will not damage the instrument.

### Using Shielded Wiring 1-25.

Shielded wires and sensors (such as thermocouples) should be used in environments where "noisy" voltage sources are present. When shielded wiring is used, the shield is normally connected to the L (low) input terminals for each channel. Alternate configurations should be examined for each equipment application.

### Crosstalk 1-26.

The instrument allows the mixing of various types of measurement. A phenomenon known as crosstalk can cause one signal to interfere with another and thereby introduce measurement errors. To reduce the effects of crosstalk in making measurement connections, do the following:

- Keep any input wiring carrying ac volts signals physically separate from the input wiring of other sensitive channels.
- Avoid connecting inputs with ac volts signals adjacent to sensitive channel inputs. Leave unconnected channels between the inputs, if possible.
- Avoid connecting inputs with ac volts signals to any channel 10 numbers away from a sensitive channel (i.e., 4-terminal input channels).
- Avoid tying L (low) or (especially) H (high) inputs of a sensitive channel to earth (chassis) ground. This is very important in resistance measurements.
- Avoid high-source impedances on sensitive channels, or minimize the capacitance of the sensitive channel to earth (chassis) ground for high impedance inputs.
- Whenever high ohms measurements (> 10kΩ) must be made accurately, avoid connecting any inputs carrying ac volts signals.

Measurement errors introduced by crosstalk are discussed in Appendix C.

### Universal Input Module Connections 1-27.

For channels 1 through 20, use the H (high) and L (low) inputs on the rear panel Universal Input Module, as shown in Figure 1-5. Perform the following procedure to make connections to the Universal Input Module:

**WARNING**

**INPUTS MAY BE CONNECTED TO LIVE VOLTAGES. TO AVOID ELECTRIC SHOCK, REMOVE INPUTS FROM LIVE VOLTAGES BEFORE OPENING THIS MODULE.**

1. Remove the module from the rear panel by pressing the release tab on the bottom of the module and then pulling the module out of its connector.
2. Loosen the two large screws on top and open the module
3. Connect the wires to H (high) and L (low) for each channel.

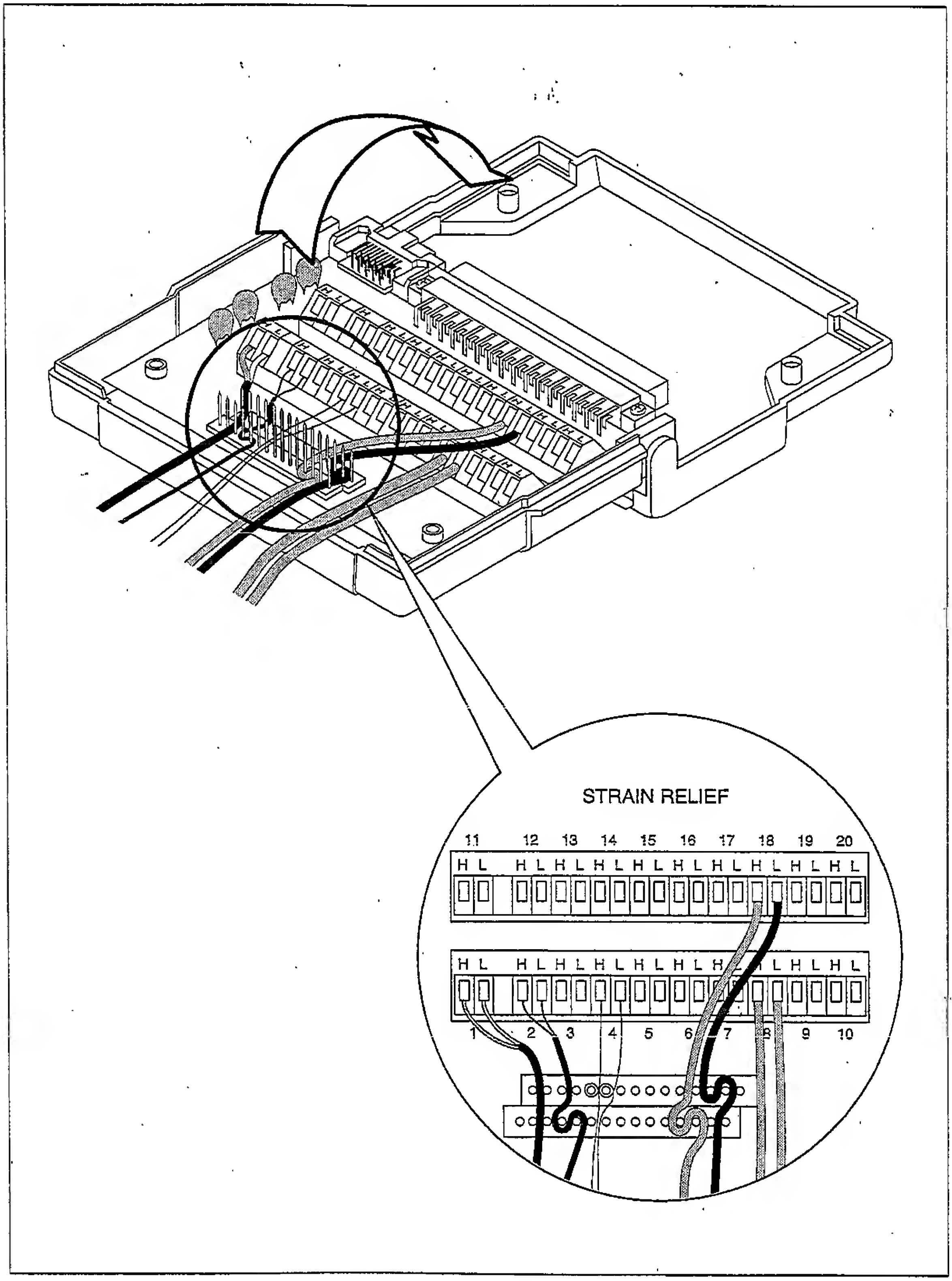



Figure 1-5. Universal Input Module Connections

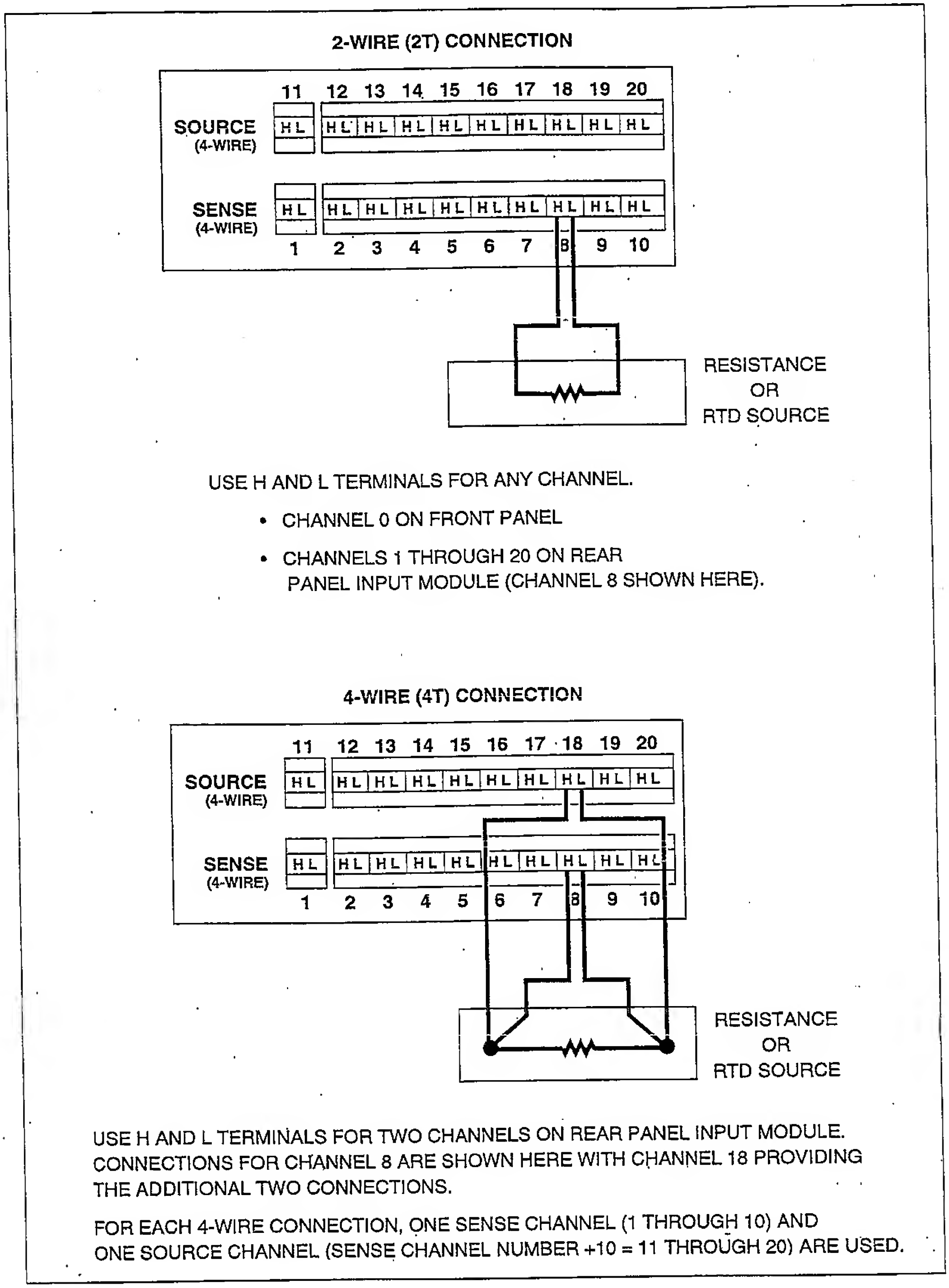



**Figure 1-6. Two-Terminal and Four-Terminal Connections**

4. Thread these wires through the strain-relief pins and out the back of the module.
5. Close the module cover, secure the screws, and insert the module in the connector at the rear of the instrument until it latches in place.

*NOTE*

*Channel 0 on the front panel does not support thermocouple measurements.*

Resistance and RTD measurements can be made with two terminals (one channel) or four terminals (two channels). The four-terminal connection provides increased accuracy (nominal 1%) over the two-terminal connection. Refer to Figure 1-6.

## ALARM OUTPUTS Connections 1-28.

The eight-terminal rear panel ALARM OUTPUTS connector (Figure 1-7) serves three functions: DC power, alarm outputs, and external trigger input. Each is described below.

### DC POWER

The instrument may be powered by a dc input between 9 volts and 16 volts allowing remote operation from various battery sources or dc power supplies. Connect the positive lead of the power supply to the + terminal and the negative lead to the - terminal. If the instrument is going to measure voltages greater than 50 volts dc or ac rms, also connect a ground wire between the rear panel ground lug and a suitable earth (safety) ground point (see Figure 1-4).

### ALARM OUTPUTS

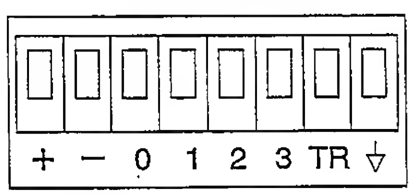
Terminals 0, 1, 2, and 3 are used to signal alarm conditions for channels 0, 1, 2, and 3 respectively using transistor-transistor-logic (TTL) voltage levels, referenced to the ' terminal. Logic high is >+2.0 to <+5.5V dc; a logic low is 0.0 to +0.8V dc. If a channel is not in alarm, the voltage output at a connector terminal is a logical high (nominal +5V dc); if a channel is in alarm, the output is a logical low (nominal +0.7V dc). Alarm outputs are set at the end of a scan interval. See Setting the Alarms in Section 2 for more information. If the instrument is operated over the RS-232 computer interface, the ALARM OUTPUTS can be assigned to I/O functions (assuming channels 0, 1, 2, and 3 are not configured for alarms). See the ALARM_DO_LEVEL command, described in Section 4.

### EXTERNAL TRIGGER INPUT

An external trigger input can serve the same function as the front panel SCAN key. The trigger input is a contact closure between TR and ' or a TTL logical low applied to TR (referenced to ' ), which causes the instrument to scan. When the trigger input is removed, scanning will stop. Scanning is initiated on the falling edge of the trigger signal, which must be held logic low for at least 5 us and have been preceded by at least 100 ms of logic high. Logic high is +2.0 to +7.0V dc; a logic low is -0.6 to +0.8V dc. See "Scan Triggering Options" in Section 2 for more information.

| Terminal | Function |
|---|---|
| + | Positive Input for DC Operation |
| – | Negative Input for DC Operation |
| 0 | Channel 0 Alarm Output |
| 1 | Channel 1 Alarm Output |
| 2 | Channel 2 Alarm Output |
| 3 | Channel 3 Alarm Output |
| TR | External Trigger Input |
| ⏚ | Ground Terminal |

ALARM OUTPUTS




9-16 V ⎓
DC PWR

**Figure 1-7. ALARM OUTPUTS Connector**

Perform the following procedure to make connections to the ALARM OUTPUTS connector:

1. Remove the connector from the rear panel.
2. Loosen the wire clamp screw for the associated terminal.
3. Feed the wire into the gap between the connector body and the wire clamp.
4. Tighten the wire clamp screw.
5. Insert the connector in the rear panel.

## DIGITAL I/O Connections 1-29.

The ten-terminal rear panel DIGITAL I/O connector (Figure 1-8) serves two functions: Digital I/O and Totalizer input. Each is described below.

### DIGITAL I/O

Terminals 4 through 7 are used to signal alarm conditions for channels 4 through 20 (default setting) using TTL voltage levels, referenced to the ' terminal. Logic high is >+2.0 to <+5.5V dc; a logic low is 0.0 to +0.8V dc. If a channel is not in alarm, the voltage output at a connector terminal is a logical high (nominal +5V dc); if a channel is in alarm, the output is a logical low (nominal +0.7V dc). Alarm outputs are changed at the end of each scan. See "Setting the Alarms" in Section 2 for more information. All alarm associations can be removed using computer commands, allowing the I/O terminals to be assigned to other functions as determined by computer commands. See the ALARM_ASSOC_CLR and related commands, described in Section 4.

### TOTALIZER INPUT

The totalizer is an internal counter that sums contact closures or voltage transitions. Connection is to the $\Sigma$ terminal, referenced to ' . A contact closure and opening, or a voltage transition rising edge will cause the totalizer to advance by one count. The maximum count allowed is 65535 and the maximum count rate is 5 kHz. Voltages trigger on a low-to-high transition at a nominal threshold of +1.4 volts. A contact debounce feature is available when the instrument is operated through the RS-232 computer interface using the TOTAL_DBNC command, described in

| Terminal | Function |
|---|---|
| 0 | Input/Output Line 0 |
| 1 | Input/Output Line 1 |
| 2 | Input/Output Line 2 |
| 3 | Input/Output Line 3 |
| 4 | Input/Output Line 4 |
| 5 | Input/Output Line 5 |
| 6 | Input/Output Line 6 |
| 7 | Input/Output Line 7 |
| $\Sigma$ | Totalizer Input |
| ⏚ | Ground Terminal |

DIGITAL I/O

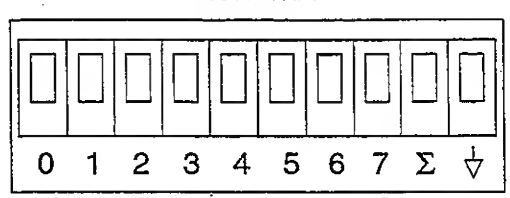



Figure 1-8. DIGITAL I/O Connector

Section 4.

Perform the following procedure to make connections to the DIGITAL I/O connector:

1. Remove the connector from the rear panel.
2. Loosen the wire clamp screw for the associated terminal.
3. Feed the wire into the gap between the connector body and the wire clamp.
4. Tighten the wire clamp screw.
5. Insert the connector in the rear panel.

## CONTROLS AND INDICATORS 1-30.

The front panel (Figure 1-1) provides a multipurpose display and a set of control keys. Each is described in the following paragraphs.

### Front Panel Controls 1-31.

The front panel keys (Figure 1-9) control all instrument operation: channel configuration, instrument configuration, measurement functions, and print/communications selections. Table 1-3 provides a summary of front panel key functions.

### Front Panel Indicators 1-32.

The front panel indicators are divided into three portions: Primary Display (Figure 1-10), Secondary Display (Figure 1-11), and Display Annunciators (Figure 1-12). Table 1-4 describes each annunciator function.

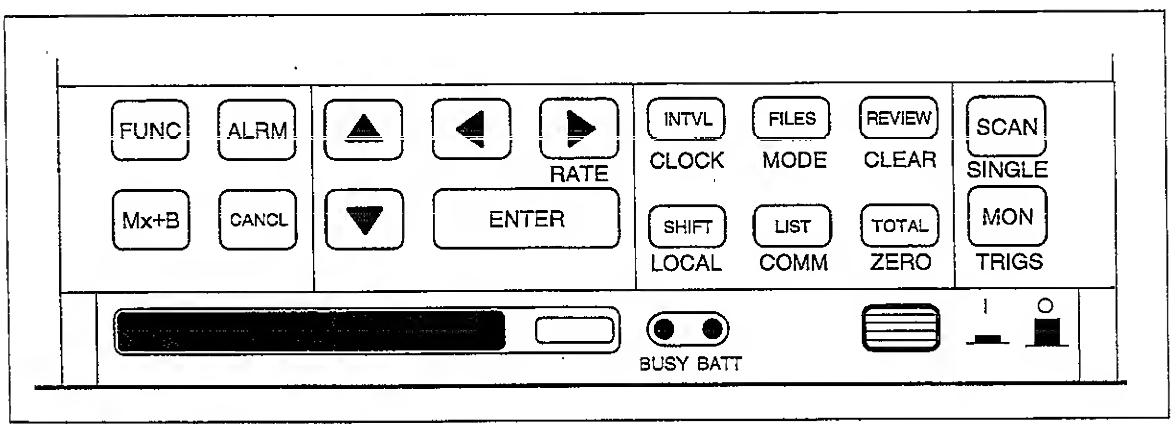



Figure 1-9. Front Panel Keys

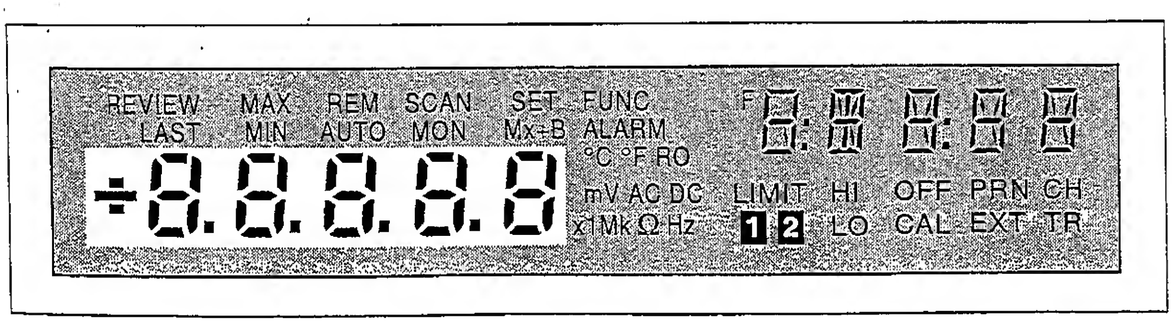



Figure 1-10. Primary Display

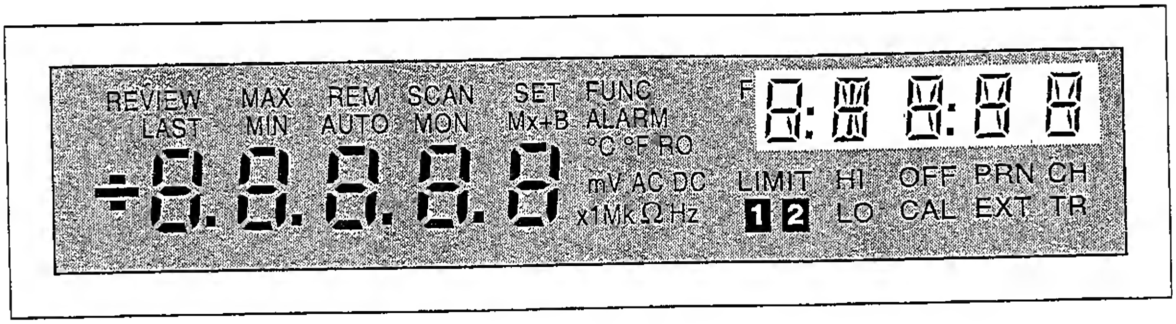



**Figure 1-11. Secondary Display**

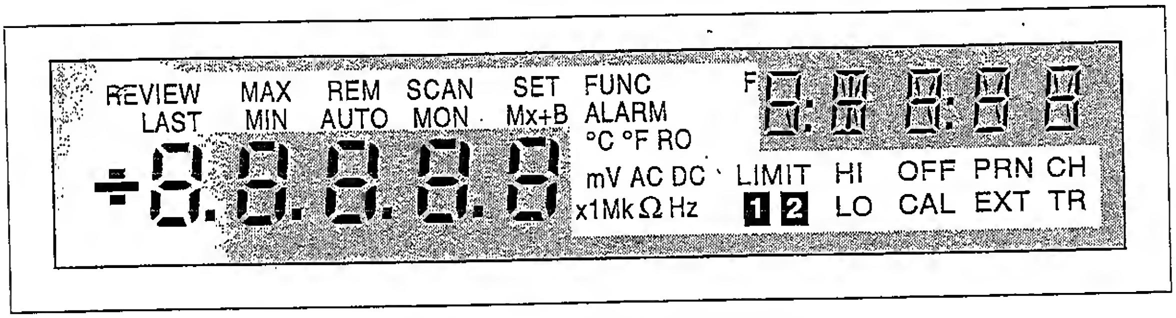



**Figure 1-12. Annunciator Display**

**Table 1-3. Front Panel Keys Description**

| Key | Description |
|---|---|
| FUNC | Calls up the menu to set the function for the channel. |
| ALRM | Calls up the menu to set alarm limits [1] and [2] for the channel. |
| Mx+B | Calls up the menu to set scaling on the channel. |
| CANCL | Used to exit any setup menu and return to Inactive Mode, without saving settings you've selected thus far. Exceptions exist under the following two conditions:<br><br>If you cancel out of the alarm menu part way through defining alarm limit [2], any just-made entries for alarm limit [1] will still take effect.<br><br>If you cancel out of the Mx+B menu part way through defining the B value, any just-made entries for the M value will still take effect.<br><br>This key also provides a handy way to remove the Totalizer value or Review data from the display. |
| Up/Down Arrows | Used to change the channel number and to step through choices in any of the setup menus. These arrow keys have an automatic repeat action when held down for more than 1 second. |
| Right/Left Arrows | Used to step through choices in several of the setup menus. These arrow keys have an automatic repeat action when held down for more than 1 second. |

Table 1-3. Front Panel Keys Description (Continued)

| Key | Description |
|---|---|
| ENTER | Used to accept a selection just made in any setup menu. |
| INTVL | Allows you to change the scan interval. Scanning becomes continuous when the interval is set to 0:00:00. |
| FILES | Accesses menus related to memory card operation, including status, directory, and manipulation of all SExx and dAtxx files. |
| REVIEW | Calls up the Review array of MIN, MAX and LAST values to the display. |
| SHIFT | Accesses secondary functions under various keys, as described below. When this key is pressed, "SHIFt" appears on the right display, but automatically disappears if you have not made a selection within 5 seconds or press CANCL. |
| LIST | Prints out the Last values of the Review array or contents of the memory card directory via the RS-232 computer interface. |
| TOTAL | Calls up the present Totalizer count to the display. |
| SCAN | Turns the Scan function on or off.<br>Triggers a single scan when the instrument is under remote control without lockout (REMS). |
| MON | Turns the Monitor function on or off. |
| RATE [SHIFT-ARROW] | Allows you to change the scanning speed: "Slo" for highest accuracy, or "FASt" for highest throughput. |
| CLOCK [SHIFT-INTVL] | Allows you to set the internal day/date clock. |
| MODE [SHIFT-FILES] | Allows you to select the destination and conditions for which scan measurements will be automatically printed or logged. |
| CLEAR [SHIFT-REVIEW] | This key sequence clears the entire contents of the Review array. Review data must be presently shown on the display to clear the array. |
| LOCAL [SHIFT] | When under remote control without lockout (REMS), this returns control to the front panel. |
| COMM [SHIFT-LIST] | Allows you to set up the computer interface port. |
| ZERO [SHIFT-TOTAL] | While the Totalizer count is displayed, resets the Totalizer to 0. |
| SINGLE [SHIFT-SCAN] | Forces an immediate scan of all defined channels. If a scan is presently in progress, this new request is ignored. Once begun, the full scan is completed. Configuration changes are not allowed while a scan is in progress. |
| TRIGS [SHIFT-MON] | Allows you to set up the auxiliary scan trigger mechanisms. |

Table 1-4. Annunciator Display Description

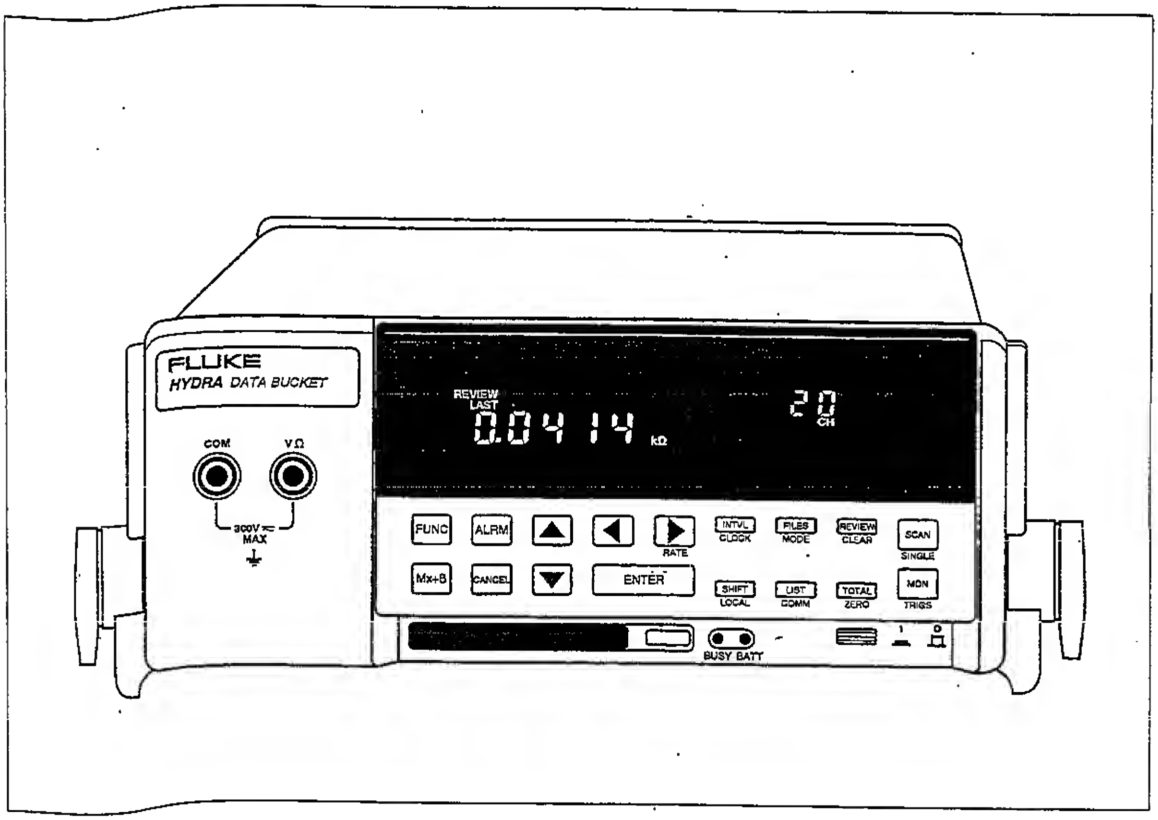
| Annunciator | Description |
|---|---|
| MON | Indicates that the Monitor function is enabled. |
| SCAN | Indicates that the Scan function is enabled. Scanning can be enabled as a single scan (SHIFT-SCAN), with a scan interval, with an alarm-trigger, or with an external trigger. |
| CH | Indicates that the channel number is displayed immediately above, in the right display. |
| SET | Lit when the instrument is in Configuration Mode. |
| Mx+B | Lit while Mx+B scaling is being defined and when a measurement on the display has been scaled with an M value other than 1 and/or a B value other than 0. Also dimly lit when in the Inactive Mode to indicate that an M value other than 1 and/or a B value other than 0 has been defined for this channel. |
| FUNC | Lit when a measurement function is being defined for this channel. |
| ALARM | Lit when alarm values are being defined for this channel or when an alarm limit has been exceeded while measuring. |
| V | Indicates that the measurement function is volts for this channel (used with the AC or DC annunciator). |
| DC | Indicates that the measurement function is dc voltage for this channel. |
| AC | Indicates that the measurement function is ac voltage for this channel. |
| Ω | Indicates that the measurement function is resistance for this channel. |
| Hz | Indicates that the measurement function is frequency for this channel. |
| °C | Indicates that the measurement function is temperature for this channel and that the degree unit is Celsius. |
| °F | Indicates that the measurement function is temperature for this channel and that the degree unit is Fahrenheit. |
| m | (milli) a multiplier for the displayed value, e.g., mV for millivolts. Also used when defining alarm and Mx+B values. |
| x1 | (times 1) a multiplier for the displayed value. Used when defining alarm and Mx+B values. |
| k | (kilo) a multiplier for the displayed value, e.g., kHz for kilohertz. Also used when defining alarm and Mx+B values. |
| M | (mega) a multiplier for the displayed value,e.g., MΩ for megohms. Also used when defining alarm and Mx+B values. |
| R0 | Lit when the ice point resistance is being defined for RTD measurements on the displayed channel. |
| OFF | Indicates there is no measurement function defined for the displayed channel; OFF channels are skipped over when scanning. OFF is also used when defining an alarm value to indicate that the alarm limit is to be ignored. |
| AUTO | Indicates that autoranging is enabled for the displayed channel. |
| LIMIT | Used with the [1] and [2] annunciators when you are setting an alarm limit value. Also lit when displaying a measurement value (LAST, Monitor) which has exceeded an alarm limit. |

**Table 1-4. Annunciator Display Description (Continued)**

| Annunciator | Description |
|---|---|
| 1 | Lit when alarm limit 1 is being defined. Also lit when displaying a measurement value (LAST, Monitor) which has exceeded alarm limit 1. |
| 2 | Lit when alarm limit 2 is being defined. Also lit when displaying a measurement value (LAST, Monitor) which has exceeded alarm limit 2. |
| HI, LO | Identifies alarm limit sensing (high or low) during channel configuration. At other times, identifies an alarm condition. |
| REVIEW | Indicates that review data is being displayed (used in conjunction with the MIN, MAX, and LAST annunciators). |
| MIN, MAX | Indicates that the displayed value is the minimum (maximum) value measured on this channel. |
| LAST | Indicates that the displayed value is the most recent scan measurement taken on this channel. |
| PRN | Indicates that the autoprint function is enabled (to send readings to a printer or PC) or the memory storage function is on (to store readings in a memory card). |
| EXT | Indicates that external triggering (on the rear panel) is enabled. |
| TR | Indicates that internal triggering (from the monitor alarm) is enabled. Also used with EXT when external triggering is enabled. |
| REM | Indicates that the instrument is under the control of the RS-232 computer interface (bright) or a front panel lockout option has been enabled (dim). |
| CAL | Indicates that the instrument's internal calibration constants have been corrupted. |
| F | (Not used.) |

# Section 2
# Front Panel Operations

## CONTENTS


FLUKE
HYDRA DATA BUCKET
REVIEW
LAST
0.0414
kΩ
20
CH
COM
VΩ
300V
MAX
FUNC
ALRM
RATE
INTVL
CLOCK
FILES
MODE
REVIEW
CLEAR
SCAN
SINGLE
Mx+B
CANCEL
ENTER
SHIFT
LOCAL
LIST
COMM
TOTAL
ZERO
MON
TRIGS
BUSY BATT

## SUMMARY OF FRONT PANEL OPERATIONS 2-1.

Descriptions of all equipment operations start at the front panel and proceed through the following topics, which appear in the following sequence:

- Preparing for Operation
- Configuring a Measurement Channel
- Setting Operating Conditions
- Operating Modes
- Additional Features
- Instrument Interfaces

This section applies exclusively to instrument applications that use only the front panel controls and annunciators. Other sections apply specifically to applications that use the memory card feature or interface with a computer, printer, or modem. It is assumed that the user has understood the information in Section 1, "Preparation for Use," including such topics as setting up the instrument and making measurement connections. Perform the Ten-Minute Tour at the front of this manual for a quick overview of instrument operation.

All the procedures in this section use control/annunciator diagrams that provide the control sequences and expected indicators for each operation. A summary of how to use the control/annunciator diagrams is shown in Figure 2-1.

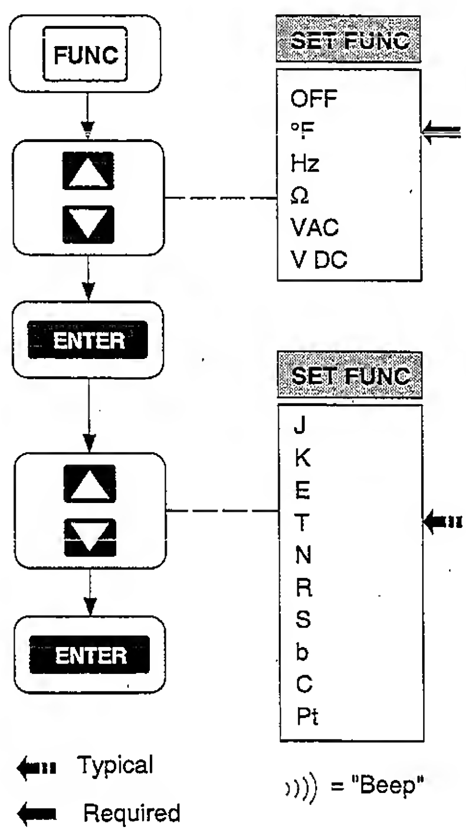
Press then release the front panel key shown. In this example, press the FUNC key.

Use the up/down arrow keys to select an item from the displayed menu.

When the menu item selected with the up/down arrow keys is correct, press the ENTER key.

When there are multiple selections, the procedure will continue.

A dotted pointer indicates a typical menu selection, while a solid pointer indicates a required selection.




The shaded portion above a menu indicates a front panel display for that menu. In this example, the menu is called SET FUNC.

A solid pointer means the menu selection is required. In this example, °F must be selected.

A dotted arrow means the menu selection is typical and the user must choose the item that meets the instrument application. In this example, a typical choice is thermocouple T.

A procedure that includes an audible "beep" will use a beep symbol as shown.

**Figure 2-1. How to Use the Control/Annunciator Diagrams**

## CONFIGURING THE INSTRUMENT FOR OPERATION 2-2.

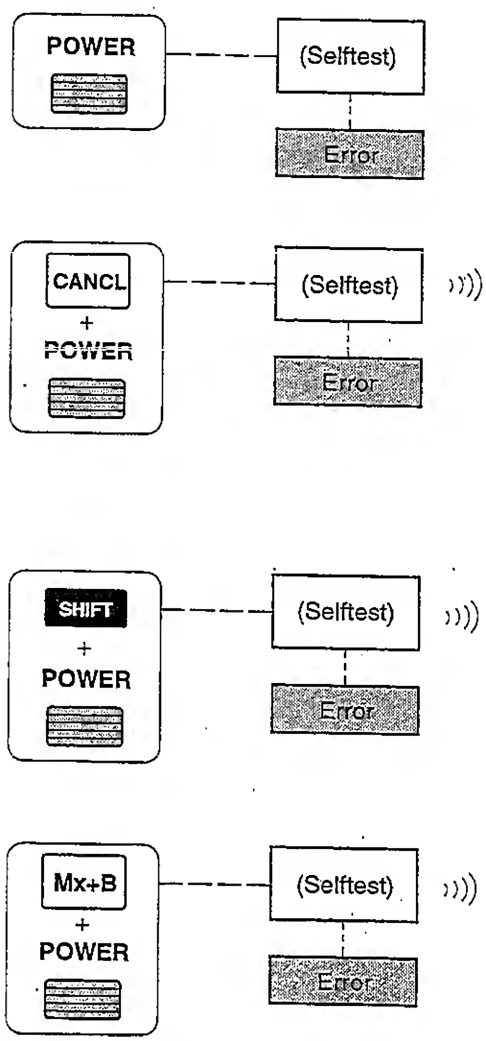
To prepare the equipment for front panel operations, perform the two following procedures:

- Turning the Power On (Figure 2-2)
- Selecting a Channel (Figure 2-3)

### Turning the Power ON 2-3.

There are four power-on options. Figure 2-2 describes the control sequences for each option.

Each power-on sequence includes a four-second selftest routine that lights the front panel display. If the selftest fails, the instrument will beep and display ERROR plus an alphanumeric error code character (see Table 2-2). If there is more than one error, each is displayed in sequence at two-second intervals. Refer to the maintenance information in Section 7 for guidance on what to do when an error is detected.




**Simple Power-On.** Press the POWER switch. After selftest, the display clears and the instrument resumes whatever operation was in effect when power was last removed.

**Configuration-Reset Power-On.** Hold down the CANCL key and press the POWER switch. Hold the CANCL key until the instrument completes selftest and "beeps" in acknowledgement. All channel configuration data is erased and the operating parameters are set to default settings (see Table 2-1). The temperature scale and communication settings are not affected.

**Display-Hold Power-On.** Hold down the SHIFT key and press the POWER switch. Hold the SHIFT key until the instrument completes the selftest routine and "beeps" in acknowledgement. The front panel display will remain lit until any key is pressed.

**Temperature-Toggle Power-On.** Hold down the Mx+B key and press the POWER switch. Hold the Mx+B key until the instrument completes selftest, "beeps" in acknowledgement, displaying either °F or °C. To select the other temperature scale, remove power and repeat the procedure.

**Figure 2-2. Turning the Power On**

**Table 2-1. Configuration Reset (Default) Settings**

| PARAMETER/DEFAULT SETTING | |
|---|---|
| Channels 0 to 20 | Off |
| Measurement Rate | Slow |
| Mx+B Scaling | 1x+0 (all channels) |
| Scan Interval | 0:00:00 (continuous) |
| Review Values | Cleared (all channels) |
| Digital I/O Lines | Set High (non-alarm) |
| Totalizer | 0/Debounce Disabled |
| Destination | None |
| RTD R0 | 100.00 (all channels) |
| Open Thermocouple Detection (OTC) | Enabled |
| Alarm Limits | Off/Limit Values=0 |

| PARAMETER/DEFAULT SETTING | |
|---|---|
| Alarm Assignments | Channels 0 to 3, to ALARM OUTPUTS 0 to 3.<br><br>Channels 4 to 20, to DIGITAL I/O as below: |

| DIGITAL I/O LINE | 4 | 5 | 6 | 7 |
|---|---|---|---|---|
| Alarm Channel (ORed to drive each I/O line) | 4 | 5 | 6 | 7 |
| | 8 | 9 | 10 | 11 |
| | 12 | 13 | 14 | 15 |
| | 16 | 17 | 18 | 19 |
| | 20 | | | |

**Table 2-2. Selftest Error Codes**

| CODE | DESCRIPTION | CODE | DESCRIPTION |
|---|---|---|---|
| 1 | Boot ROM Checksum Error | 7 | Instrument Calibration Data Corrupted |
| 2 | Instrument ROM Checksum Error | 8 | Instrument Not Calibrated |
| 3 | Internal RAM Test Failed | 9 | A-to-D Converter Not Responding |
| 4 | Display Power-Up Test Failed | A | A-to-D Converter ROM Test Failed |
| 5 | Display Not Responding | b | A-to-D Converter RAM Test Failed |
| 6 | Instrument Configuration Corrupted | C | A-to-D Converter Selftest Failure |
| | | d | Memory Card Interface Not Installed |

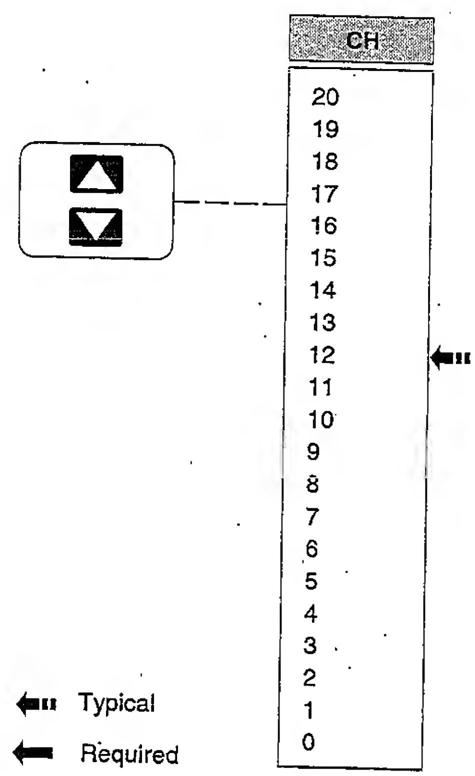
## Selecting a Channel 2-4.

There are 21 channels, 0 to 20. A channel is selected for configuration or configuration verification when the instrument is in the inactive mode. An active channel is selected for monitoring when the instrument is in the Monitor Mode (see Figure 2-17) or Review Mode (see Figure 2-18). Perform the procedure in Figure 2-3 to select a channel.

RESTRICTIONS

Locked Out Channels. Any channel 1 to 10 (n) assigned to four-terminal (4T) measurements locks out a corresponding channel a decade higher (n+10). For example, use of channel 3 for 4T measurements locks out channel 13, which can be selected, but not configured.

Restricted Channels. Channel 0 (front panel terminals) does not support thermocouple measurements or four-terminal measurements.




**Selecting a Channel.** Press the up/down arrow keys until the CH (Channel) display shows the desired channel, for example, CH 12 (Channel 12).

Figure 2-3. Selecting a Channel

## CONFIGURING A MEASUREMENT CHANNEL 2-5.

The following paragraphs provide configuration procedures for DC Volts, AC Volts, Resistance, Frequency, Temperature, and describe how to turn a channel Off:

- Configuring a Channel to Measure DC Volts (Figure 2-4)
- Configuring a Channel to Measure AC Volts (Figure 2-5)
- Configuring a Channel to Measure Resistance (Figure 2-6)
- Configuring a Channel to Measure Frequency (Figure 2-7)
- Configuring a Channel to Measure Temperature (Thermocouples) (Figure 2-8)
- Configuring a Channel to Measure Temperature (RTDs) (Figure 2-9)
- Configuring a Channel Off (Figure 2-10)

The instrument is protected from channel configuration errors. For example, accidentally applying 300V ac to a channel configured for resistance will not damage the instrument.

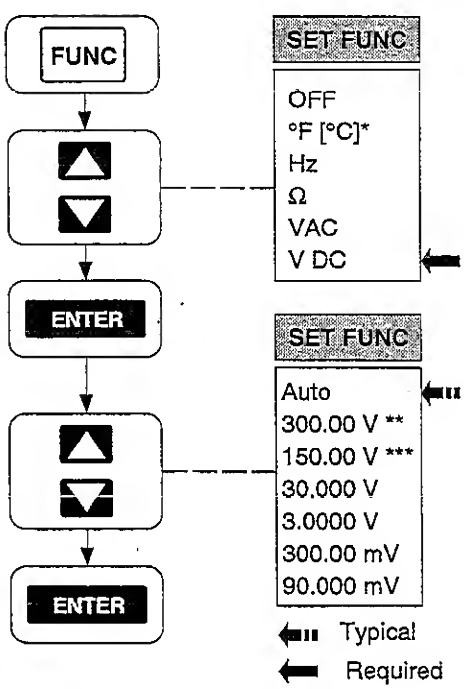
### Configuring a Channel to Measure DC Volts 2-6.

Perform the procedure in Figure 2-4 to configure a channel for measuring dc volts. In preparation, the instrument must be in the inactive mode (not scanning or monitoring) and the desired channel must be selected (see Figure 2-3). To exit at any time (changes not saved), press the CANCL key.

RESTRICTIONS

Maximum Input. The maximum voltage inputs are 300V dc for channels 0, 1, 11, and 150V dc for channels 2 to 10, and 12 to 20.

90.000 mV Range. Not used in Auto (autoranging).




**Selecting the DC Volts Mode.** Press the FUNC key to access the SET FUNC (Set Function) menu. Press the up/down arrow keys until V DC (volts dc) is displayed, then press the ENTER key.

**Selecting the Measurement Scale.** Select a fixed scale or Auto (autoranging). A fixed scale indicates an upper measurement limit. For example, the 30.000 V scale measures 30 volts or less. Measurements beyond the scale limit will cause an OL (overload) display. The x1 (1.0) multiplier indicates a reading in volts dc; the m multiplier (0.001) indicates a reading in millivolts dc. A 900.00 mV range is available by computer interface and may appear in the display if this was previously selected.

In Auto (autoranging), the instrument chooses the scale for the best measurement resolution. When the scales are changed, the scan is momentarily slowed.

* Depends on temperature scale.
** Channels 0, 1, and 11.
*** Channels 2 to 10, and 12 to 20.

**Figure 2-4. Configuring a Channel to Measure DC Volts**

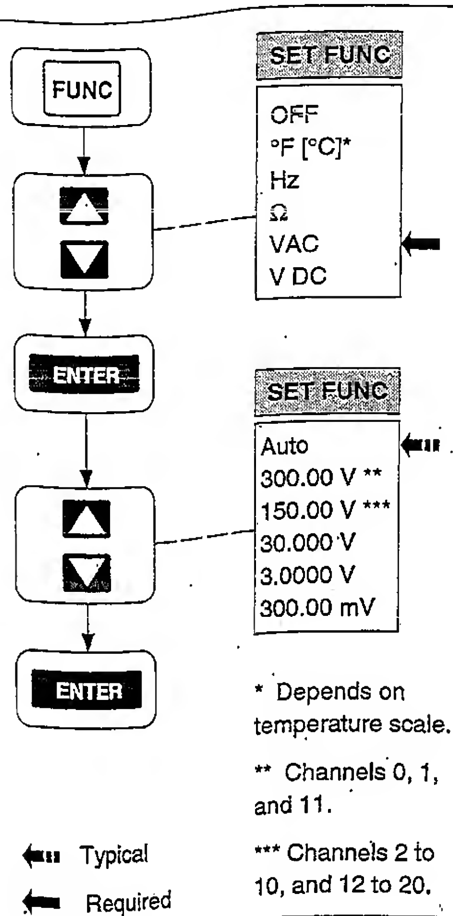
## Configuring a Channel to Measure AC Volts 2-7.

Perform the procedure in Figure 2-5 to configure a channel for measuring ac volts. In preparation, the instrument must be in the inactive mode (not scanning or monitoring) and the desired channel must be selected (see Figure 2-3). To exit at any time (changes not saved), press the CANCL key.

RESTRICTIONS

<u>Maximum Input</u>. The maximum voltage inputs are 300V ac (rms) for channels 0, 1, 11, and 150V ac (rms) for channels 2 to 10, and 12 to 20.

<u>Frequency</u>. The frequency range for maximum voltage inputs is 20 Hz to 100 Hz. Refer to Appendix A for derated voltage inputs for frequencies between 100 Hz and 100 kHz.




**Selecting the AC Volts Mode.** Press the FUNC key to access the SET FUNC (Set Function) menu. Press the up/down arrow keys until VAC (Volts AC) is displayed, then press the ENTER key.

**Selecting the Measurement Scale.** Select a fixed scale or Auto (autoranging). A fixed scale indicates an upper measurement limit. For example, the 30.000 V scale measures 30 volts or less. Measurements beyond the scale limit will cause an OL (overload) display. The x1 (unity or x 1) multiplier indicates a reading in volts ac; the m (milli or x .001) multiplier indicates a reading in millivolts ac.

In Auto (autoranging), the instrument chooses the scale for the best measurement resolution. When the scales are changed, the scan is momentarily slowed.

* Depends on temperature scale.

** Channels 0, 1, and 11.

*** Channels 2 to 10, and 12 to 20.

Figure 2-5. Configuring a Channel to Measure AC Volts

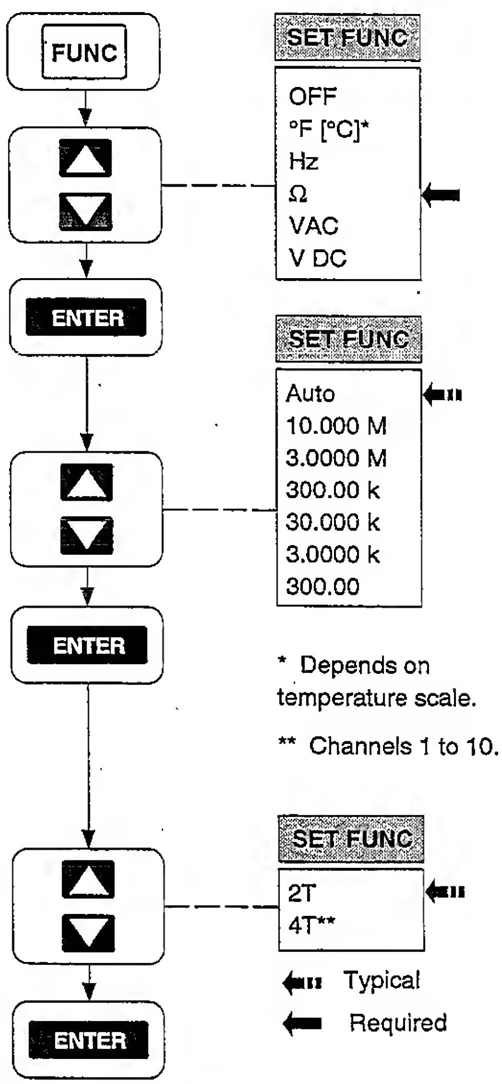
## Configuring a Channel to Measure Resistance 2-8.

Perform the procedure in Figure 2-6 to configure a channel for measuring resistance. In preparation, the instrument must be in the inactive mode (not scanning or monitoring) and the desired channel must be selected (see Figure 2-3). To exit at any time (changes not saved), press the CANCL key.

The resistance to be measured can be connected using one channel (two-terminal connection) or two channels (four-terminal connection). The four-terminal connection provides increased measurement precision. The two channels used in a four-terminal connection are a decade apart (n and n+10), for example, channel 3 (n) and 13 (n+10). Only the lower channel is configured.

### RESTRICTIONS

Four-Terminal Channels. Four-Terminal configurations are limited to channels 1 to 10 (n). The channel a decade higher (n + 10) is automatically reserved for use.




**Selecting the Resistance Mode.** Press the FUNC key to access the SET FUNC (Set Function) menu. Press the up/down arrow keys until Ω (ohms) is displayed, then press the ENTER key.

**Selecting the Measurement Scale.** Select a fixed scale or Auto (autoranging). A fixed scale indicates an upper measurement limit. For example, the 30.000 kΩ scale measures 30 kΩ ohms or less. Measurements beyond the scale limit will cause an OL (overload) display. The x1 (unity or x 1) multiplier indicates a reading in ohms; the k (kilo or x 1,000) multiplier indicates a reading in kilohms; the M (mega or x 1,000,000) multiplier indicates a reading in megohms.

In Auto (autoranging), the instrument chooses the scale for the best measurement resolution. When scales are changed, the scan is momentarily slowed.

**Selecting the Terminal Mode.** Select the two-terminal (2T) or four-terminal (4T) mode. 4T automatically clears configuration data from the channel a decade higher (n+10). For example, selecting channel 3 for 4T operation will automatically clear channel 13 of all configuration data and lock it out from further use.

**Figure 2-6. Configuring a Channel to Measure Resistance**

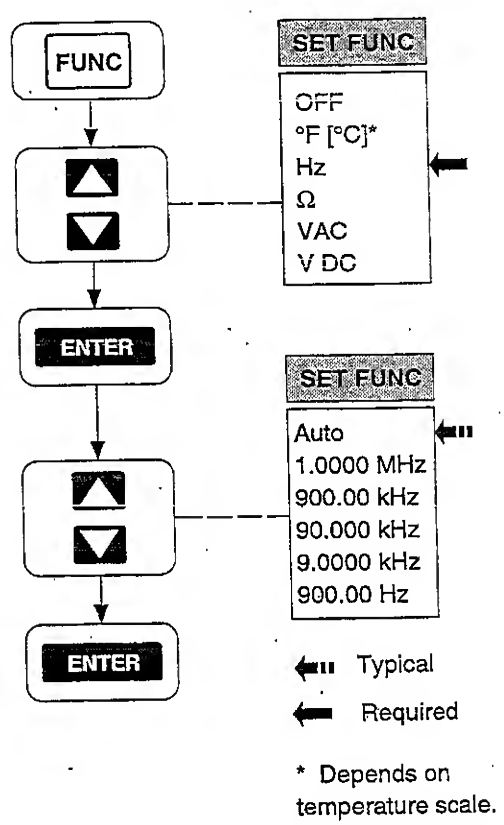
## Configuring a Channel to Measure Frequency 2-9.

Perform the procedure in Figure 2-7 to configure a channel for measuring frequency. In preparation, the instrument must be in the inactive mode (not scanning or monitoring) and the desired channel must be selected (see Figure 2-3). To exit at any time (changes not saved), press the CANCL key.

RESTRICTIONS

<u>Frequency Range</u>. The frequency range for measurements is 15 Hz minimum to greater than 1 MHz.

<u>Maximum Input</u>. The maximum voltage inputs are 300V ac (rms) for channels 0, 1, 11, and 150V ac (rms) for channels 2 to 10, and 12 to 20. The frequency range for maximum voltage inputs is 15 Hz to 100 Hz. Refer to Appendix A for derated voltage inputs for frequencies between 100 Hz and 100 kHz.




**Selecting the Frequency Mode.** Press the FUNC key to access the SET FUNC (Set Function) menu. Press the up/down arrow keys until Hz (Hertz) is displayed, then press the ENTER key.

**Selecting the Measurement Scale.** Select a fixed scale or Auto (autoranging). A fixed scale indicates an upper measurement limit. For example, the 90.000 kHz scale measures 90 kHz or less. Measurements beyond the scale limit will cause an OL (overload) display. The x1 (unity or x 1) multiplier indicates a reading in Hz; the k (kilo or x 1,000) multiplier indicates a reading in kilohertz; the M (mega or x 1,000,000) multiplier indicates a reading in megahertz.

In Auto (autoranging), the instrument chooses the scale for the best measurement resolution. There are no scanning delays with frequency autoranging.

**Figure 2-7. Configuring a Channel to Measure Frequency**

## Configuring a Channel to Measure Temperature 2-10.

Perform the procedure in Figure 2-8 to configure a channel for measuring temperature with thermocouples, or Figure 2-9 to measure temperature with resistance-temperature detectors (RTDs). In preparation, the instrument must be in the inactive mode (not scanning or monitoring) and the desired channel must be selected (see Figure 2-3). To exit at any time (changes not saved), press the CANCL key. The temperature scale, °C or °F, is set by the Temperature-Toggle Power-On procedure (see Figure 2-2). When under computer control, an open thermocouple default can be set by the TEMP_CONFIG command.

### THERMOCOUPLES

Thermocouples are formed by joining two wires of dissimilar metals, which produce a voltage proportional to the temperature of the wire junction. The instrument conditions this voltage into temperature measurements. Voltage conditioning includes compensation for the type of thermocouple used and measurement-process compensation that uses a reference temperature sensor built into the Input Module (channels 1 to 20). The front panel terminals (channel 0) cannot be used for thermocouples. The instrument supports nine standard thermocouples, each identified with an American National Standards Institute (ANSI) alpha character (except [ ]): J, [C], B, S, R, N, T, E, or K. A thermocouple type is selected as part of the channel configuration. Table 2-3 summarizes the ranges and characteristics of the supported thermocouples, including the lead colors for the high (H) and low (L) connections to the Universal Input Module. The instrument displays "otc" when an open thermocouple is detected (as selected with the TEMP_CONFIG command - see Section 4).

### RESISTANCE-TEMPERATURE DETECTORS

Resistance-Temperature Detectors (RTDs) are formed from coils or strips of metal, usually platinum, the resistance of which varies with temperature. The instrument conditions this resistance into temperature measurements. The instrument supports any platinum RTD that is calibrated to the IEC 751 Standard ($\alpha$=0.00385 ohms/ohm/°C). RTDs are characterized by their resistance at 0 °C (32 °F), which is called the "ice point" or R0. The most common R0 is 100 ohms. The instrument supports any IEC 751 Platinum RTD with an R0 from 000.00 to 999.99, with a default of R0=100.00. Since RTDs are resistance devices, they can be connected to the instrument using one channel (two-terminal connection) or two channels (four-terminal connection). A four-channel configuration provides increased measurement precision. Some RTDs can be purchased in a four-terminal configuration, facilitating a four-terminal connection. The two channels used in a four-terminal connection are a decade apart (n and n+10), for example, channel 3 (n) and 13 (n+10). Only the lower channel is configured.

### THERMOCOUPLE RESTRICTIONS:

Channel 0. Thermocouple measurements cannot use channel 0.

Open Thermocouple. The instrument displays OTC when an open thermocouple is detected and ignores the channel while scanning.

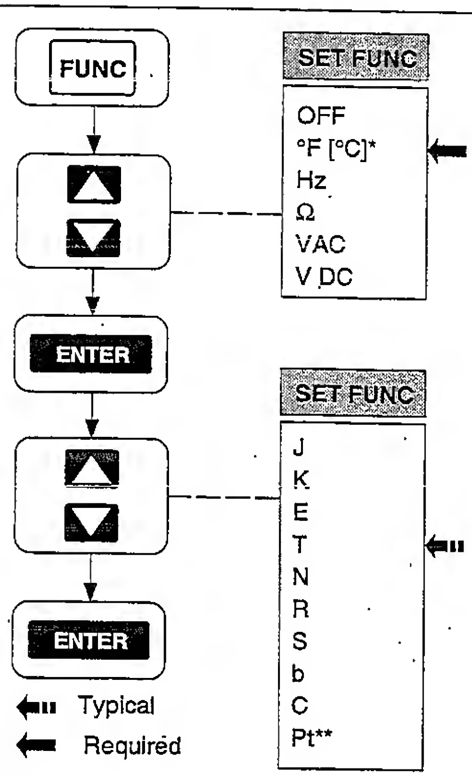
### RESISTANCE TEMPERATURE DETECTORS RESTRICTIONS:

Four-Terminal Channels. Four-Terminal configurations are limited to channels 1 to 10 (n). The channel a decade higher (n + 10) is automatically reserved for use.

### Table 2-3. Thermocouple Ranges

| TYPE | MATERIAL | POSITIVE LEAD (H) COLOR: ANSI* | POSITIVE LEAD (H) COLOR: IEC** | NEGATIVE LEAD MATERIAL | USABLE RANGE (C°) |
|---|---|---|---|---|---|
| J | Iron | White | Black | Constantan | -200 to 760 |
| C*** | Tungsten (5% Rhenium) | White | | Tungsten (26% Rhenium) | 0 to 2316 |
| b | Platimum (30% Rhodium) | Gray | | Platinum (6% Rhobium) | 0 to 1820 |
| S | Platinum | Black | Orange | Platinum (10% Rhodium) | -50 to 1768 |
| R | Platinum | Black | Orange | Platinum (13% Rhodium) | -50 to 1768 |
| N | NICROSIL | Orange | | NISIL | -270 to 1300 |
| T | Copper | Blue | Brown | Constantan | -270 to 400 |
| E | Chromel | Purple | Violet | Constantan | -270 to 1000 |
| K | Chromel | Yellow | Green | Alumel | -270 to 1372 |

* American National Standards Institute (ANSI) device negative lead (L) is always red.
** International Electrotechnical Commission (IEC) device negative lead (L) is always white.
*** Not an ANSI designation but a Hoskins Engineering Company designation.



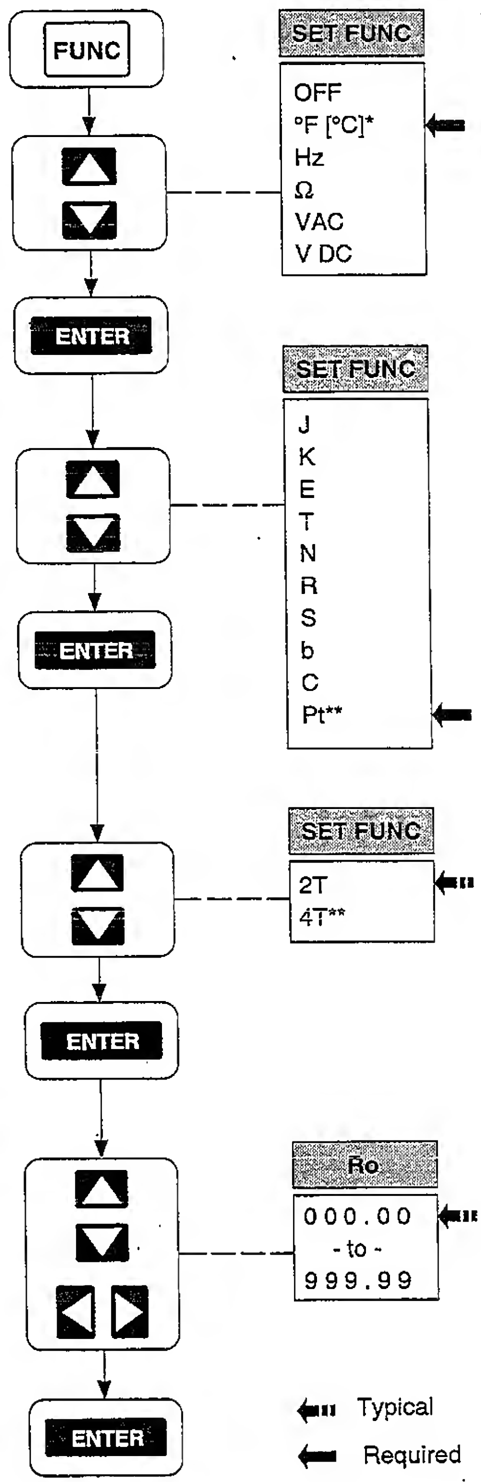

**Selecting the Temperature Mode.** Press the FUNC key to access the SET FUNC (Set Function) menu. Press the up/down arrow keys until °C (Centigrade) or °F (Fahrenheit) is displayed, then press the ENTER key. (If the opposite temperature scale is desired, refer to Figure 2-2.)

**Selecting the Type of Thermocouple.** Select the desired type of thermocouple from the menu, for example, T, then press ENTER. The "Pt" (Platinum) setting is used for RTDs only (See Figure 2-9).

* Depends on temperature scale.

** Only Pt can be selected for Channel 0.

**Figure 2-8. Configuring a Channel to Measure Temperature (Thermocouples)**




**Selecting the Temperature Mode.** Press the FUNC key to access the SET FUNC (Set Function) menu. Press the up/down arrow keys until °C (Centigrade) or °F (Fahrenheit) is displayed, then press the ENTER key. (If the opposite temperature scale is desired, refer to Figure 2-2.)

**Selecting the RTD Mode.** Select Pt (Platinum), then press the ENTER key.

**Selecting the Terminal Mode.** Select the two-terminal (2T) or four-terminal (4T) mode. 4T automatically clears configuration data from the channel a decade higher (n+10). For example, selecting channel 3 for 4T operation will automatically clear channel 13 of all configuration data and lock it out from further use.

**Selecting the "Ice Point" (R0).** Use the up/down and left/right arrow keys to enter the desired number, then press the ENTER key. The default and most common setting is 100.00 (R0=100.00 ohms at 0 °C [32 °F]).

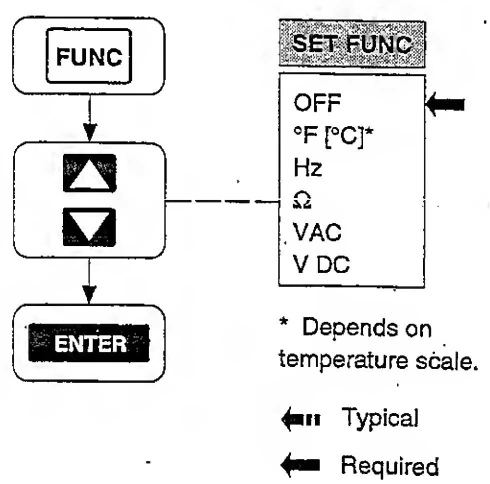
* Depends on temperature scale.

** Channels 1 to 10.

**Figure 2-9. Configuring a Channel to Measure Temperature (RTDs)**

## Configuring a Channel Off 2-11.

Perform the procedure in Figure 2-10 to configure a channel for off (no measurement). In preparation, the instrument must be in the inactive mode (not scanning or monitoring) and the desired channel must be selected (see Figure 2-3). To exit at any time (changes not saved), press the CANCL key. When a channel is OFF, it cannot be scanned or monitored. When a channel function is changed, alarm limits and scaling (Mx+B) for that channel are changed to their default conditions.




**Selecting the OFF Mode.** Press the FUNC key to access the SET FUNC (Set Function) menu. Press the up/down arrow keys until OFF is displayed, then press the ENTER key.

**Figure 2-10. Configuring a Channel Off**

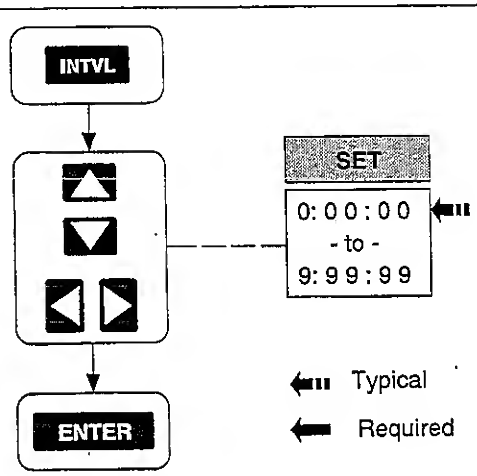
## SETTING OPERATING CONDITIONS 2-12.

After the channels are configured for the desired measurement parameter, set the following operating conditions to support the intended instrument function:

- Setting the Scan Interval [Default - 0:00:00 (Continuous)] (Figure 2-11)
- Setting the Measurement Rate [Default - Slow] (Figure 2-12)
- Setting the Alarms [Default - Alarms off] (Figures 2-13)
- Setting the Mx+B Scaling [Default - 1x+0 (no scaling] (Figure 2-14)

### Setting the Scan Interval 2-13.

Perform the procedure in Figure 2-11 to set the time between starts of measurement scans. In preparation, the instrument must be in the inactive mode (not scanning or monitoring). To exit at any time (changes not saved), press the CANCL key. The scanning interval format is HOURS:MINUTES:SECONDS. The minimum is 0:00:00 (continuous scanning [default]); the maximum is 9:99:99 (9 hours, 99 minutes, 99 seconds). The scan interval is divided into two portions: the measurement interval when measurements are actually taken, and the time-out interval that completes the overall scan duration. For example, if 10 channels can be measured in 8 seconds, and the scanning interval is set for 30 seconds, the first 8 seconds are used for measurement, while the remaining 22 seconds are used to time out. If the scanning interval is set to less than the measurement rate, the effect is continuous scanning. For example, if 10 channels can be measured in 8 seconds and the scanning interval is set for 5 seconds, scanning is continuous. To speed up the measurement rate, refer to Figure 2-12.

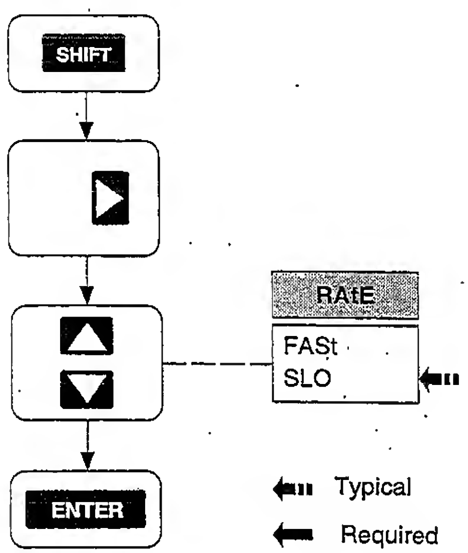



**Setting the Scan Interval.** Press the INTVL (Interval) key to access the scan time menu. The format is HOURS:MINUTES:SECONDS. Press the up/down and left/right arrow keys to select and configure each column in the menu. For example, a scan interval of 1 hour, 25 minutes, and 33 seconds would be formatted as 1:25:33. The column being configured will have a bright display. When the display shows the desired interval, press the ENTER key.

**Figure 2-11. Setting the Scan Interval**

## Setting the Measurement Rate 2-14.

Perform the procedure in Figure 2-12 to set a fast or slow [default] measurement rate. The measurement rate affects the time required to scan the configured channels. However, the fast mode sacrifices one digit of measurement resolution. For example, a temperature reading of 72.4 °F in the slow mode would become 72 °F in the fast mode, or 27.858V dc in the slow mode would become 27.86 V dc in the fast mode. The fast mode is normally used to capture rapidly changing measurements or to speed up the measurement portion of the scan interval.




**Setting the Measurement Rate.** Press the SHIFT key and then the right-arrow key to access the measurement rate menu. Press the up/down arrow keys to select either SLO (Slow) or FASt (Fast), then press the ENTER key.

Figure 2-12. Setting the Measurement Rate

## Setting the Alarms 2-15.

Perform the procedure in Figure 2-13 to set alarm limits for any configured channel. In preparation, the instrument must be in the inactive mode (not scanning or monitoring) and the desired channel must be configured with a measurement function (see Figures 2-4 to 2-9) and selected (see Figure 2-3). To exit at any time, press the CANCL key; however, any alarm parameters previously entered will remain. Two alarm limits, alarm 1 and alarm 2, can be defined for each channel. If applied to a channel with Mx+B scaling, the alarm is based on the scaled values. An alarm occurs when the measured value on the channel moves above the HI (High) or below the LO (Low) value. Alarms can start autoprinting (Figure 5-3), start scanning with the Monitor-Alarm trigger option (Figure 2-19), or trigger other functions via the rear panel digital outputs. In the inactive mode, any selected channel that is programmed with alarm limits will display LIMIT plus 1 and/or 2 to show which alarms have been set. In the different operating modes, the front panel will provide an indication of a channel in an alarm condition. Each is discussed below.

### ALARM INDICATIONS WHILE SCANNING

If a scanned channel is in an alarm condition during the scan, the ALARM annunciator is turned on (dim display). If all alarm conditions clear during the next scan, the ALARM annunciator is turned off. See Figure 2-15 for information about the Scan Mode.

### ALARM INDICATIONS WHILE MONITORING

If the channel being monitored is in an alarm condition, the alarm limit 1 and/or 2 annunciators will be turned on, and the ALARM annunciator blinks bright/dim. The alarm limit annunciator indicates which alarm has been exceeded. If the monitored channel is not in alarm, the ALARM annunciator will be off, unless scanning and some other channel is in alarm, then the ALARM indicator has a steady dim display. See Figure 2-17 for information about the Monitor Mode.

### ALARM INDICATIONS WHILE REVIEWING

If the channel being reviewed had been in an alarm condition, the ALARM and alarm limit 1 and/or 2 annunciators will be turned on. The alarm limit annunciator indicates which alarm has been exceeded. See Figure 2-18 for information about the Review Mode.

### CLEARING ALARM PARAMETERS FROM A CHANNEL

To clear alarm parameters from a channel, the alarm can be programmed to OFF for both alarm 1 and alarm 2, or the channel function can be changed to any other selection, including OFF.

### ALARM OUTPUTS FOR CHANNEL 0 TO 3 USING THE ALARM OUTPUTS CONNECTOR

A dedicated transistor-transistor logic (TTL) voltage output is available for channel 0 to channel 3 alarms, via the rear panel ALARM OUTPUTS connector. (See Section 1 of this manual for connection information.) If a channel is not in alarm, the voltage output at a connector terminal is a logical high (nominal +5V dc); if a channel is in alarm, the output is a logical low (nominal +0.7V dc). Alarm outputs are set following each scan. As shown in Table 2-4, there are 16 different alarm combinations. The decimal equivalent of the binary half-byte formed by Channel 3 to Channel 0 has significance in autoprinting operations. (See the following discussion on autoprinting.)

## ALARM OUTPUTS FOR CHANNELS 4 TO 20 USING THE DIGITAL I/O CONNECTOR

A shared transistor-transistor logic (TTL) voltage output is available for channel 4 to channel 20 alarms via the rear panel DIGITAL I/O connector, using terminals I/O 7 to I/O 4. (See Section 1 of this manual for connection information.) If a channel is not in alarm, the voltage output at a connector terminal is a logical high (nominal +5V dc); if a channel is in alarm, the output is a logical low (nominal +0.7V dc). Alarm outputs are set following each scan. As shown in Table 2-5, the alarm outputs for channels 4 to 20 are ORed in groups. For example, a logical low at I/O 7 indicates that channel 7 or 11 or 15 or 19 is in an alarm condition. Dedicated alarm channels are available only for channels 0 to 3 (see the above). Assigning alarms to channels 4 to 20 does not disable the associated I/O output from use by commands from the computer interface. (See using the "Digital Input/Output Lines" under "Additional Features.") The decimal equivalent of the binary byte formed by I/O 7 to I/O 0 has significance in autoprinting operations (see the following discussion) and for certain commands in the instrument command set, e.g., LOG?.

**Table 2-4. TLL Alarm Outputs (Channels 0 to 3)**

| CHANNEL 3 | CHANNEL 2 | CHANNEL 1 | CHANNEL 0 | DECIMAL |
|---|---|---|---|---|
| 0 (Alarm) | 0 (Alarm) | 0 (Alarm) | 0 (Alarm) | 0 |
| 0 | 0 | 0 | 1 (No Alarm) | 1 |
| 0 | 0 | 1 (No Alarm) | 0 | 2 |
| 0 | 0 | 1 | 1 | 3 |
| 0 | 1 (No Alarm) | 0 | 0 | 4 |
| 0 | 1 | 0 | 1 | 5 |
| 0 | 1 | 1 | 0 | 6 |
| 0 | 1 | 1 | 1 | 7 |
| 1 (No Alarm) | 0 | 0 | 0 | 8 |
| 1 | 0 | 0 | 1 | 9 |
| 1 | 0 | 1 | 0 | 10 |
| 1 | 0 | 1 | 1 | 11 |
| 1 | 1 | 0 | 0 | 12 |
| 1 | 1 | 0 | 1 | 13 |
| 1 | 1 | 1 | 0 | 14 |
| 1 | 1 | 1 | 1 | 15 |

1 = No Alarm    0 = Alarm

Note 1. The decimal equivalent of the binary half-byte formed by Channel 3 to Channel 0 is used in autoprint functions.

Note 2. The TTL alarm outputs are via the ALARM OUTPUTS rear panel connector.

## ALARMS AND AUTOPRINTING

Alarm conditions are indicated for each scanned channel when using the autoprint function, and the ALM (Alarm) and DIO (Digital I/O) conditions are summarized with a decimal number. (See Tables 2-4 and 2-5.) An alarm condition can be used to turn autoprinting on and off by selecting "Print" (printer) or "both" (printer and memory card) as a data destination, and the data mode as ALAr (Alarm) (see Figure 5-3). When scanning using the front panel SCAN key, the printer will print measurement results when any scanned channel is in alarm. If scanning using the alarm trigger (see Figure 2-19), the printer will print measurement results only when the monitored channel is in alarm.

## ALARMS AND MONITOR-ALARM TRIGGERING

An alarm condition, coupled with the Monitor Mode, can be used to start and stop measurement scans (see Figure 2-19). When an alarm occurs, scanning begins, and when the alarm clears, scanning stops.

## ALARMS AND Mx+B SCALING

Alarm settings are affected by Mx+B scaling. The Mx+B scaling determines the value that the instrument displays, and the alarms are configured for these values.

**Table 2-5. TTL Alarm Outputs (Channels 4 to 20)**

| CHANNELS | CHANNELS | CHANNELS | CHANNELS | |
|---|---|---|---|---|
| 7 -or-<br>11 -or-<br>15 -or-<br>19 | 6 -or-<br>10 -or-<br>14 -or-<br>18 | 5 -or-<br>9 -or-<br>13 -or-<br>17 | 4 -or-<br>8 -or-<br>12 -or-<br>16 -or-<br>20 -or- | |
| **I/O 7** | **I/O 6** | **I/O 5** | **I/O 4** | **DECIMAL** |
| 0 (Alarm) | 0 (Alarm) | 0 (Alarm) | 0 (Alarm) | 31 |
| 0 | 1 (No Alarm) | 1 (No Alarm) | 1 (No Alarm) | 127 |
| 1 (No Alarm) | 0 | 1 | 1 | 191 |
| 1 | 1 | 0 | 1 | 223 |
| 1 | 1 | 1 | 0 | 239 |
| 1 | 1 | 1 | 1 | 255 |

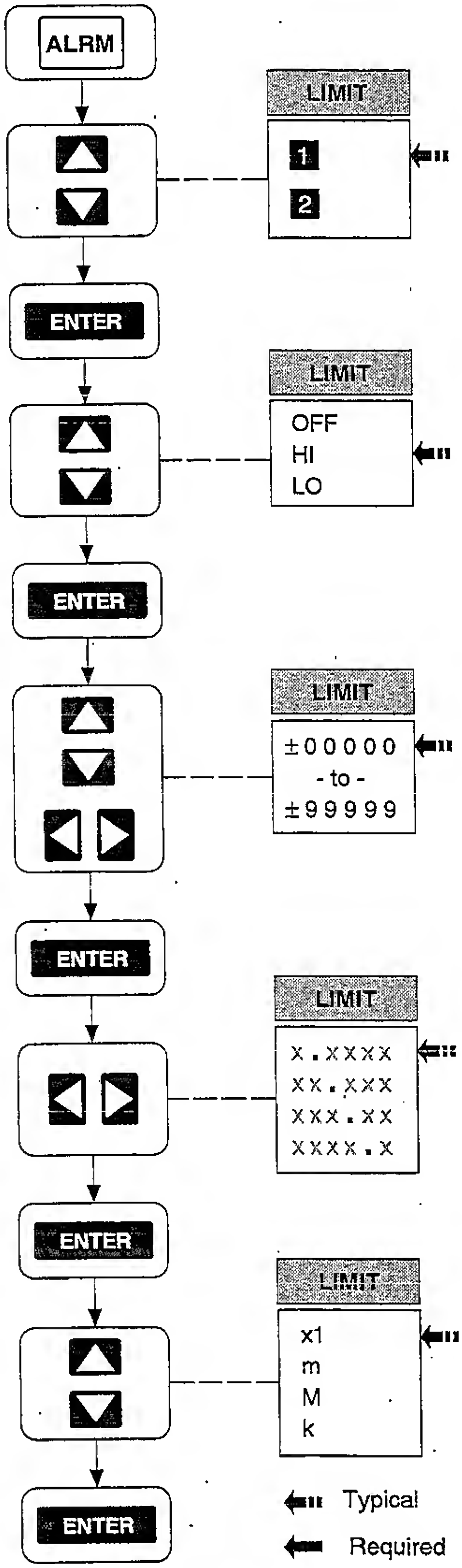
1 = No Alarm 0 = Alarm

Note 1. The decimal equivalent of the binary byte formed by Channel 4 to Channel 20 is used in autoprint and computer functions. The decimal values shown here are based on I/O 3 to I/O 0 being equal to logical 1.

Note 2. The above shows the least complicated Digital I/O alarm configurations. Multiple alarms plus the use of I/O terminals 3 to 0 can conceivably use all 255 digital I/O combinations.

Note 3. The TTL alarm outputs are via the DIGITAL I/O rear-panel connector.

Example: A logical 0 at I/O 7 terminals indicates an alarm condition for channel 7, or 11, or 15, or 19. Only channels 0 to 3 have dedicated alarm outputs on the ALARM OUTPUTS connector.




**Selecting Alarm 1 or Alarm 2.** Press the ALRM (Alarm) key to access the alarm selection menu. Use the up/down arrow keys to select alarm 1 or 2, then press the ENTER key.

**Selecting the Alarm Mode.** Press the up/down arrow keys to select an alarm mode, OFF (Off), HI (High), or LO (Low), then press the ENTER key.

**Selecting the Alarm Numerical Value.** Press the up/down and left/right arrow keys to enter a five digit number that defines the numerical value for the alarm, ignoring the decimal point or scale multiplier. The column being configured will have a bright display. For example, for an alarm of 132.75V ac, enter +13275. When the entry is correct, press the ENTER key.

**Selecting the Alarm Decimal Value.** Press the left/right arrow keys to position the decimal point in the number selected in the previous step. For the example above, the settings would be 132.75. When the decimal point is correct, press the ENTER key.

**Selecting the Alarm Scale Multiplier.** Press the up/down arrow keys to select the desired multiplier: x1 (x1), m (x .001), M (x1,000,000), or k (x1,000). For the example above, the 132.75 multiplier would be x1. When the multiplier is correct, press the ENTER key. If alarm 1 is configured, the procedure continues for alarm 2. If alarm 2 is configured, the procedure terminates.

**Figure 2-13. Setting the Alarms**

## Setting the Mx+B Scaling 2-16.

Perform the procedure in Figure 2-14 to set the Mx+B scaling for any configured channel. In preparation, the instrument must be in the inactive mode (not scanning or monitoring) and the desired channel must be configured with a measurement function (see Figures 2-4 to 2-9) and selected (see Figure 2-3). To exit at any time, press the CANCL key; however, any Mx+B parameters previously entered will remain. Scaling allows a measurement value (x) to be modified with a fixed multiplier (M) and a fixed offset (B). A channel with scaling other than the default of 1x+0 will display Mx+B when the channel is selected. When scaling is used, only a number is displayed; function identifiers such as °F, Hz, \Ω, VAC, and VDC are removed. If the results from Mx+B scaling are nonsense, double check the signs and multiplier values for M and B.

### EXAMPLES

Multiplier. If a pressure transducer provides 100 mV for 100 PSI, 200mV dc for 200 PSI, etc., the instrument would read directly in PSI with a multiplier of 1000, or M=+1k and B=000.00. For example, a PSI of 156.98 would display the number 156.98.

Offset. If you are monitoring line voltage of 115V ac and you want the instrument to display the variations above and below 115V ac instead of the actual voltage, the instrument would display the differences by subtracting -115 from the measurements, or B=-115.00 (M=1.0). For example, 117.21V ac would display only the number 2.21; 113.45V ac would display the number -1.55.

Multiplier and Offset. If the instrument is measuring temperature using the °F scale, but you want it to display the measurements in °C, the conversion formula °C=5/9(°F-32), rewritten in decimal °C=.55555°F-17.777, could make the conversion with M=+.55555 (entered as +555.55m) and B=-017.78. For example, 72.2 °F would display the number 22.28.

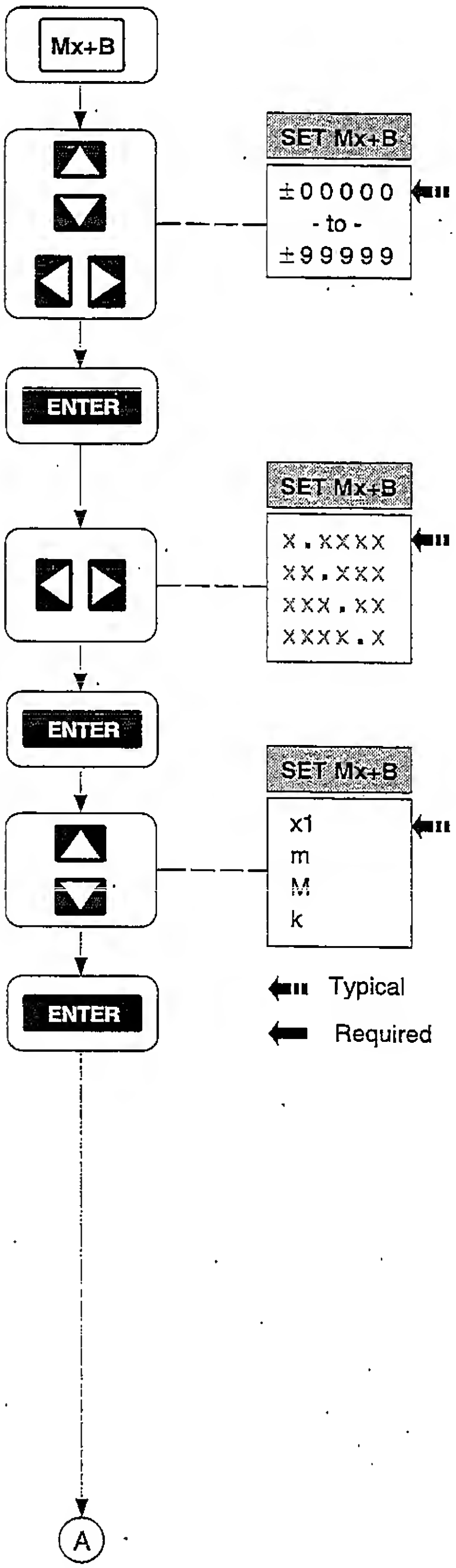
### RESTRICTIONS

Linearity. The transfer characteristic of the transducers or measurement modifications must be linear, with fixed multipliers (M) and fixed offsets (B).

Overload (OL) Display. The decimal point location and scaling (m, X1, k, M) selected for the "B" value determines the scaling for the result. For example, if B=xxx.xx x1, the result will range over ±999.99 only. Anything greater than +999.99 or less than -999.99 will show "OL" (overload).

### CLEARING Mx+B SCALING FROM A CHANNEL

To clear Mx+B parameters from a channel, the Mx+B parameters can be programmed to 1x+0 (M=1, B=0), or the channel function can be changed to any other selection, including OFF.



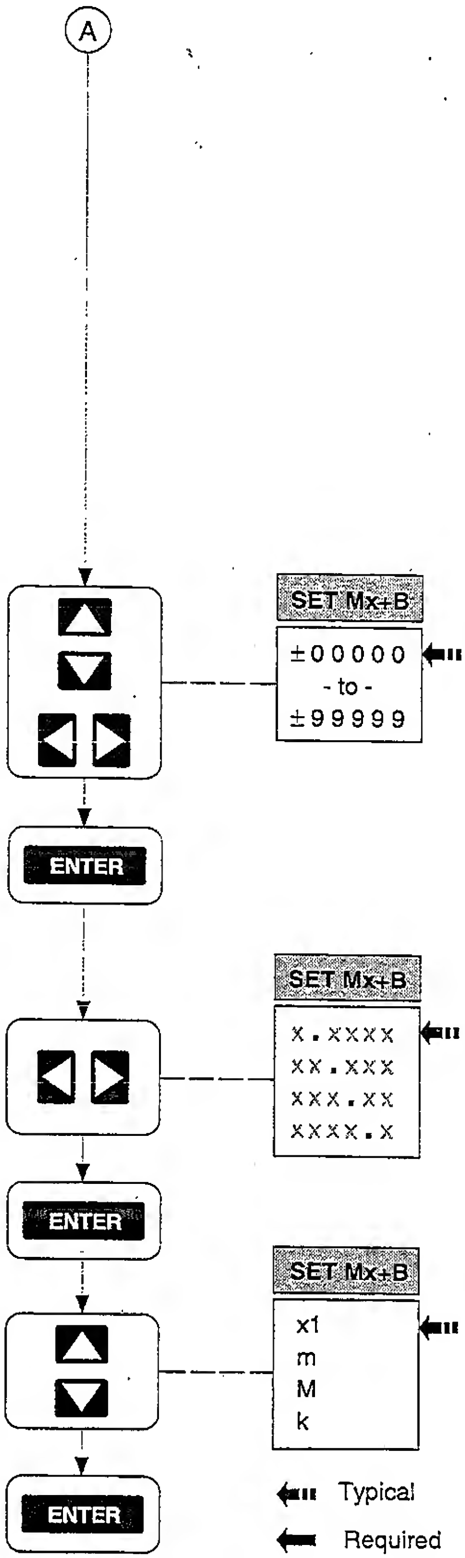

**Selecting the M Numerical Value.** Press the Mx+B key to access the Mx+B menu. Press the up/down and left/right arrow keys to enter a five digit number that defines the numerical value for the measurement multiplier, ignoring the decimal point or scale multiplier. The column being configured has a bright display. For example, for an M of 1000 (1k), enter +01000. When the entry is correct, press the ENTER key.

**Selecting the M Decimal Value.** Press the left/right arrow keys to position the decimal point in the number selected in the previous step. For the example above, the setting would be +01.000. When the decimal point is correct, press the ENTER key.

**Selecting the M Scale Modifier.** Press the up/down arrow keys to select the desired scale modifier: X1 (x1), m (x .001), M (x1,000,000), or k (x1,000). For the example above, the +01.000 scale modifier would be k. When the scale modifier is correct, press the ENTER key.

(Continued on the next page)

**Figure 2-14. Setting the Mx+B Scaling (Sheet 1 of 2)**




(Continued from the previous page)

**Selecting the B Numerical Value.** Press the up/down and left/right arrow keys to enter a five digit number that defines the numerical value for the measurement offset, ignoring the decimal point or scale multiplier. The column being configured has a bright display. For example, for a B of -115, enter -11500. When the entry is correct, press the ENTER key.

**Selecting the B Decimal Value.** Press the left/right arrow keys to position the decimal point in the number selected in the previous step. For the example above, the setting would be -115.00. When the decimal point is correct, press the ENTER key.

**Selecting the B Scale Modifier.** Press the up/down arrow keys to select the desired scale modifier: X1 (x1), m (x .001), M (x1,000,000), or k (x1,000). For the example above, the -115.00 scale modifier would be x1. When the scale modifier is correct, press the ENTER key.

Figure 2-14. Setting the Mx+B Scaling (Sheet 2 of 2)

## OPERATING MODES 2-17.

With the channels configured and operating conditions set, the instrument is ready for operation in one of the following modes:

- Using the Scan Mode (Figure 2-15)
- Using the Monitor Mode (Figure 2-17)
- Using the Review Mode (Figure 2-18)

Each operating mode is discussed below. To modify the operating mode with additional features, such as using the scan triggering, refer to the next main headings in this section, "Additional Features."

### Using the Scan Mode 2-18.

Perform the procedure in Figure 2-15 to start and stop the Scan Mode of operation. The Scan Mode can be started when the instrument is inactive, in Monitor (Figure 2-17), or Review (Figure 2-18). Measurement results can be sent to a memory card (see Section 3, "Memory Card Operations") and PC (see Section 4, "Computer Operations") or printer (see Section 5, "Printer Operations"). When using the Scan Mode with a memory card, consider each of the following topics. (Memory card error messages are summarized in Figure 2-16.)

#### MEMORY CARD AS A DATA DESTINATION

Measurement data is not automatically sent to the memory card. Measurement data can be sent to a printer/PC, to the memory card, to both printer/PC and memory card, or to neither. If either the printer/PC or memory card, or both are selected, the PRN annunciator will be on. See Figure 3-4 to set the destination and mode for sending measurement data to the memory card.

#### MEMORY CARD FORMATTING

When the instrument is inactive (not scanning or monitoring), insert a memory card. An immediate error **Err 1/CArd** indicates the memory card is not initialized (formatted). See Figure 3-3 to initialize a memory card.

#### MEMORY CARD CAPACITY

A memory card that fills during scanning displays the error **Err 3/FULL**, meaning readings are being saved in internal memory (75 scans maximum) and another card should be inserted. The error changes to **Err 4/FULL** if the internal memory fills, saving only the most recent 75 scans. When inserted, the replacement card is updated with the scans in memory.

#### MEMORY CARD FILES

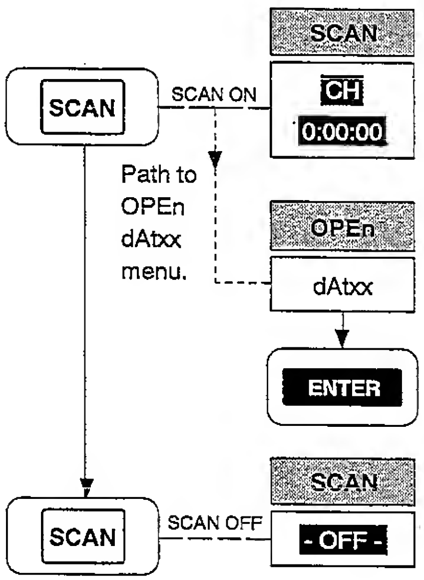
Data files (dAtxx) are opened manually (see Figure 3-8) or prompted by pressing SCAN. Press ENTER to accept file names or use the up/down and left/right arrow keys to select a file name and then press ENTER. If a data file cannot be opened, error **Err 2/FILE** will be displayed, meaning all files dAt00 to dAt99 already exist or the selected file name is already assigned.

#### MEMORY CARD EXCHANGE DURING SCANNING

Eject the active card when the BUSY indicator is off and replace with another card. The instrument opens the same file name on the new card. If this file cannot be opened, **Err 3/bAd** is displayed (see Figure 2-16). **Err4/bAd** indicates the internal memory is full, saving only the most recent 75 scans. The new card is updated with the scans in memory.

## MEMORY CARD DATA EXTRACTION

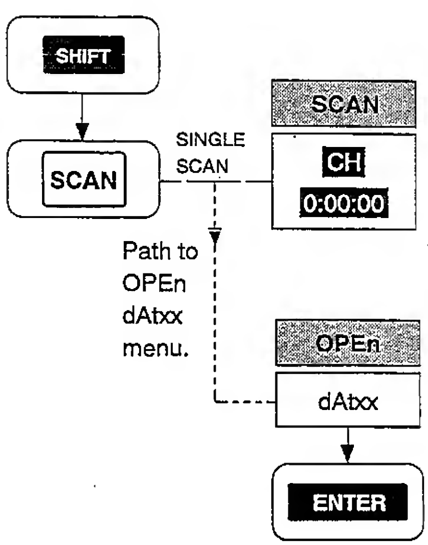
Measurement data recorded onto a memory card can be read only by a PC running Starter or Logger applications software. If you want to have a copy of the measurement data when it is being recorded, connect a printer during scan operations (see Section 5, Printer Operation). If using a printer, verify the data destination is "both" (memory card/printer) (see Figure 5-3).




**Starting the Scan Mode.** Press the SCAN key to start scanning. If the data destination includes the memory card and a data file has not been opened, a dAtxx file will be displayed. If an error message appears, refer to Figure 2-16.

**Opening a Data (dAtxx) File.** Press ENTER to open the suggested file or use the cursor keys to select a file name (00 to 99), then press ENTER. If an error message appears, refer to Figure 2–16. Press the CANCL key to exit without opening a file or starting scanning.

**Stopping the Scan Mode.** Press the SCAN key again to stop the scan mode (-OFF- will be displayed momentarily). If SCAN is pressed during the measurement interval, the measurements will be completed.




**Starting the Single Scan Mode.** Press the SHIFT key then then SCAN key for a single measure-ment scan. If the data destination includes the memory card and a data file has not been opened, a dAtxx file will be displayed. If an error message appears, refer to Figure 2-16.

**Opening a Data (dAtxx) File.** The suggested dAtxx file can be opened by pressing ENTER, or the cursor keys can be used to select a file name (00 to 99), then press ENTER. If an error message appears, refer to Figure 2-16. Press the CANCL key to exit without opening a file.

**Figure 2-15. Using the Scan Mode**

## Memory Card Error Messages 2-19.

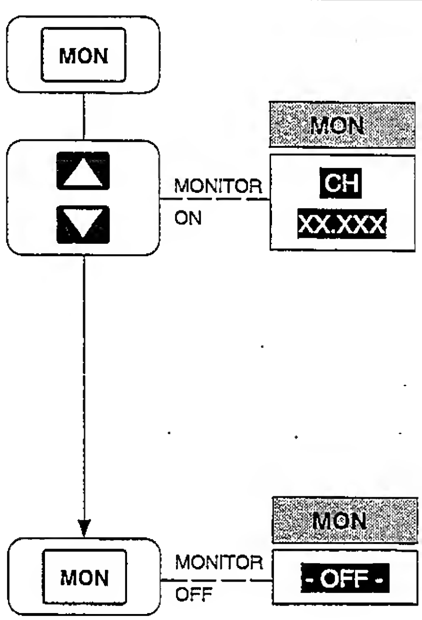
Any illegal memory card operation results in a double "beep" and an error display as shown in Figure 2-16. If the instrument is scanning and in the Monitor Mode or Review Mode, only the double beep will be heard for a memory card error. Error messages are acknowledged by pressing the ENTER or CANCL key or by ejecting the memory card.

| Display | Description |
|---|---|
| Err 1 CArd | **Card error.** Card is missing, unformatted, full of data, or the write-protect switch is set to "read only." If error occurs when card is inserted, card is unformatted. To format a card, see Figure 3-3. To erase files, see Figure 3-7 (SEtxx files) or 3-9 (dAtxx files). To set write-protect switch, see Figure 3-1. |
| Err 2 FILE | **File error.** Unable to open a file. The selected file name is already assigned or all file names have been used (00 to 99). Select another file name, erase files (Figures 3-7 or 3-9), or use another card. |
| Err 3 | **Card problem (scans saved).** Scanned data is being stored in internal memory (75 scans maximum). Take action or the internal memory will overflow and data will be lost. Insert a usable replacement card and stored scans will be transferred to the new card. If action is delayed, the error message changes to Err 4. |
| Err 4 | **Card problem (scans lost).** The most recent 75 scans are stored in internal memory and the oldest scans are being discarded. Insert a usable replacement card and the stored scans will be transferred to the new card. |
| bAd | **Replacement card error.** The replacement card is either unformatted, full of data, the identical file name used for the current scan already exists, or the write-protect switch is in "read only." Use another card or stop scanning and correct the problem. Display alternates with Err 3 or Err 4. |
| FULL | **Active card error.** The active card recording measurement data is full. Install a replacement card and stored scans will be transferred to the new card. Display alternates with Err 3 or Err 4. |
| CArd | **Active card error.** The active card has been removed during scanning. Reinsert the same card or install a replacement card. Stored scans will be transferred to the inserted card. Display alternates with Err 3 or Err 4. |

Figure 2-16. Memory Card Error Messages

## Using the Monitor Mode 2-20.

Perform the procedure in Figure 2-17 to start and stop the Monitor Mode of operation. The Monitor Mode can be started when the instrument is in the inactive mode or in the Scan Mode. The Monitor Mode commands the instrument to display the present measurement for any selected channel (except channels set to OFF) and to display alarm information if the channel is in alarm. If the Monitor Mode is used without the Scan Mode, the instrument operates like a multimeter. If the Monitor Mode is used with the Scan Mode, the instrument also operates like a multimeter but measurements can be recorded into memory, printed out, and reviewed (maximum, minimum, last values). The Monitor-Alarm triggering option uses the Monitor Mode to start or stop scans when a selected channel goes into or out of alarm (see Figure 2-19). If the instrument is in the Monitor Mode and scanning using the memory card, any illegal memory card operations are noted only with a double "beep." When you hear a double beep, exit the Monitor Mode and investigate the memory card error (see Figure 2-16).



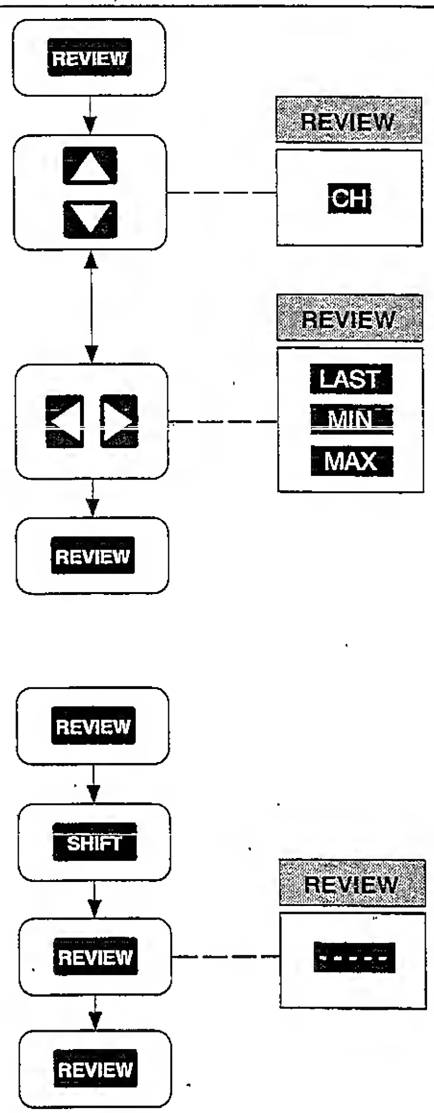

**Starting the Monitor Mode.** Press the MON key to start the Monitor Mode. Use the up/down arrow keys to select any configured channel and display the current measurement. Any monitored channel using autoranging will display AUTO. When the instrument is in the Monitor Mode, an internal relay closes every 10 seconds as part of the meter housekeeping activities. Relay closures are heard as a series of low-level audio "clicks" coming from the instrument.

**Stopping the Monitor Mode.** Press the MON key again to stop the Monitor Mode (-OFF- will be displayed momentarily). If the meter is in the Scan Mode, the front panel changes to the scan channel/interval timer display.

Figure 2-17. Using the Monitor Mode

## Using the Review Mode 2-21.

Perform the procedure in Figure 2-18 to operate the Review Mode of operation. The Review Mode is used any time during or after operation of the Scan Mode. While the instrument is in the Scan Mode, the last, maximum, and measurements for each scanned channel are stored in memory and updated with each scan, forming the Review Array. For example, during scan operations, review can be used to monitor the maximum measurement of a channel in real time. The Review Array is cleared by a control sequence (see Figure 2-18 below), or by changing any parameter of any channel or the measurement rate. The Review Array can be printed out using the LIST key (see Figure 5-4). If the instrument is in the Review Mode and scanning using the memory card, any illegal memory card operations is noted only with a double "beep." If a double beep is heard, exit the Review Mode and check the memory card error (see Figure 2-16).




**Examining the Review Values.** Press the REVIEW key to start the Review Mode. Use the up/down arrow keys to select the channel for review, then use the left/right arrow keys to view the LAST (Last), MIN (Minimum), and MAX (Maximum) values recorded during the past scan intervals (scan can be active or inactive). Repeat for each channel of interest. A series of dashes, - - - - -, indicates all review data has been cleared either by a control sequence (below), or by changing any parameter of any channel. OL indicates an overload. Press the REVIEW key to exit the Review Mode. If not cleared, review values will remain in memory for update with the next scan interval.

**Clearing the Review Array.** Press the Review key to start the Review Mode. Press the SHIFT key and then the REVIEW key to clear all review data from all channels. If the scan mode is not active, the display will change to dashes (- - - - -). If the scan mode is active, new values will appear. Press the REVIEW key again to exit the Review Mode.

**Figure 2-18. Using the Review Mode**

## ADDITIONAL FEATURES 2-22.

The following additional features allow the instrument to serve in a variety of applications:

- Scan Triggering Options (Figure 2-19)
- Totalizer Operation (Figure 2-20)
- Digital Input/Output Lines
- Setting Date and Time (Figure 2-21)
- Reading Instrument Software Versions (Figure 2-22)
- Returning to the LOCAL Mode (Figure 2-23)
- Front Panel Key Lockout Option (Figure 2-24)

### Scan Triggering Options 2-23.

Perform the procedure in Figure 2-19 to select a triggering option, which can be applied when the instrument is in the inactive mode (not scanning or monitoring). Normally, a scan is started by pressing the SCAN key, but two options can be selected to start a scan from either an external trigger input or from a monitor-alarm condition. The SCAN key overrides a triggering option.

#### EXTERNAL TRIGGER

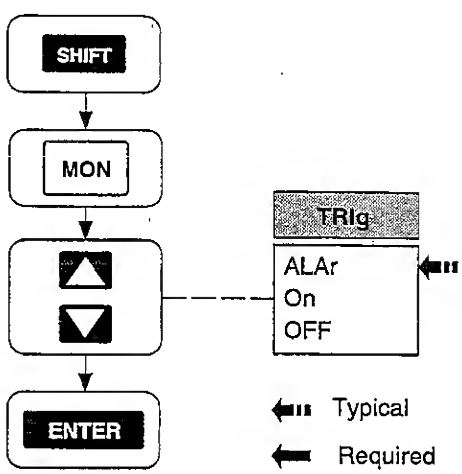
The external trigger input starts a scan from a contact closure or TTL input applied to the TR and ' inputs on the rear panel ALARM OUTPUTS connector (see Figure 1-7). This option lights the EXT TR annunciator.

#### MONITOR-ALARM TRIGGER

The Monitor-Alarm trigger starts scanning from a channel that goes into an alarm while being monitored in the Monitor Mode. When the monitored channel goes into alarm, the instrument scans for as long as the alarm condition exists. This option lights the TR annunciator.

#### TRIGGERING OPTIONS AND MEMORY CARD OPERATION

To verify the equipment setup when the memory card is used to record data, use the Single Scan mode (see Figure 2-15) to record a single scan. Any problems with the memory card or setup can be observed and corrected. If a triggering option triggers scanning without an open memory card dAtxx file, the instrument will automatically open a file when a usable memory card is in the instrument. If no memory card is installed or the memory card is not usable, the most recent 75 scans are saved in an internal memory. To record the saved scans, insert a usable memory card and open a file (see Figure 3-8). The stored scans will be transferred to the card.

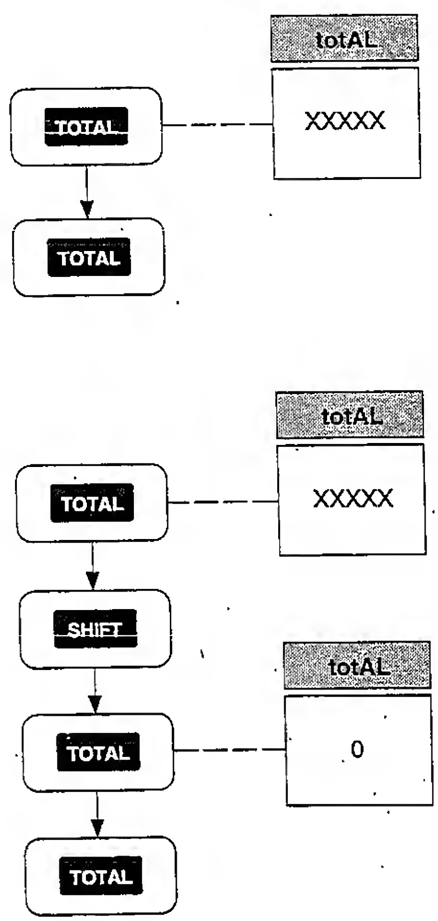



**Selecting a Trigger Option.** Press the SHIFT key and then the MON key to access the trigger option menu. Press the up/down arrow keys to select either ALAr (Alarm) (Monitor-Alarm trigger), On (On) (External trigger), or OFF (Off) (no trigger option selected), then press the ENTER key.

**Figure 2-19. Scan Triggering Options**

## Totalizer Operation 2-24.

Perform the procedure in Figure 2-20 to use the totalizer feature. The totalizer count can be monitored when the instrument is active or inactive. The totalizer is an internal counter that sums contact closures or voltage transitions. Connection is at the rear panel DIGITAL I/O connector, pins $\Sigma$ and ' . A contact closure between $\Sigma$ and ' or a voltage transition applied to $\Sigma$ (referenced to ' ), will cause the totalizer to advance by one count. The maximum count allowed is 65535 and the maximum count rate is 5 kHz. Voltages trigger on a low-to-high transition at a nominal threshold of +1.4 volts. A contact debounce feature is available when the instrument is operated through a computer interface. (See Section 4, "Computer Operations.")




**Reading the Totalizer Count.** Press the TOTAL key to view the contents of the totalizer counter. The maximum count is 65535. If the maximum count is exceeded, the display will show OL (Overload). Press the TOTAL key again to exit. To reset the counter to zero, see below, Erasing the Totalizer Count.

**Erasing the Totalizer Count.** Press the TOTAL key to view the contents of the totalizer counter. Press the SHIFT key and then the TOTAL key to reset the counter to zero. Press the TOTAL key again to exit.

**Figure 2-20. Totalizer Operation**

## Digital Input/Output Lines

**2-25.**

There are no front panel controls or annunciators for the digital input/output (I/O) lines, I/O 7 to I/O 0. Connection to the eight I/O lines is via the rear panel DIGITAL I/O connector. If a logic low is applied to any line, the instrument treats it as an input; if the instrument sets a line to logic low, the instrument treats it as an output. An output low condition takes precedence over an input high condition. All digital I/O lines are controlled by a computer interface (see Section 4, "Computer Operations"); however, as a default, lines I/O 7 to I/O 4 are used to output alarm status conditions for channels 4 to 20 (see Table 2-5). An instrument-generated I/O line alarm output takes precedence over any other configuration.

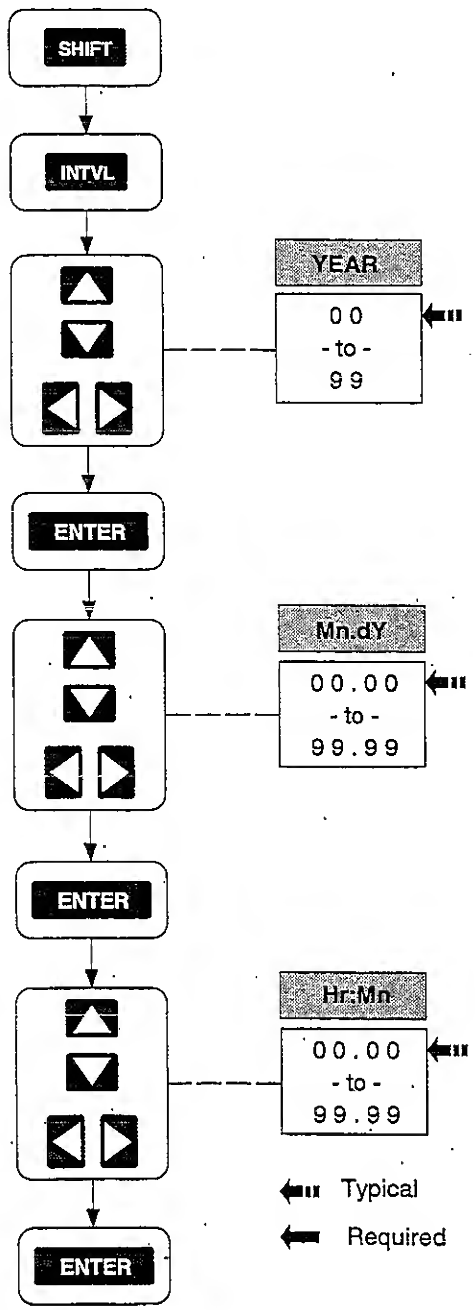
All Digital I/O lines are set high (non-active) whenever power is cycled. These lines remain high until an alarm condition or computer interface command changes an output state.

*NOTE*

*Measurements taken with the Monitor function do not affect the digital outputs.*

## Setting Date and Time 2-26.

Perform the procedure in Figure 2-21 to set the instrument internal clock and calendar, which must be correct since measurements are tagged with this time and date. The built-in clock accuracy is a nominal one minute per month. Once set to the correct date and time, clock and calendar operation is automatic and no further action is required.




**Selecting the Year.** Press the SHIFT key and then the INTVL key to enter the date/time menu. With YEAR displayed, use the up/down and left/right arrow keys to select the two numbers for the correct year, for example, 94 for 1994, then press the ENTER key.

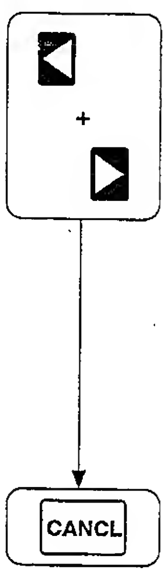
**Selecting the Month and Day.** With Mn.dY (Month.Day) displayed, use the up/down and left/right arrow keys to select four numbers for the correct month and day, for example, 07.21 for July 21, then press the ENTER key.

**Selecting the Hour and Minute.** With Hr:Mn (Hour:Minute) displayed, use the up/down and left/right arrow keys to select four numbers for the correct hour and minute (24-hour clock), for example, 14.38 for 2:38 pm, then press the ENTER key.

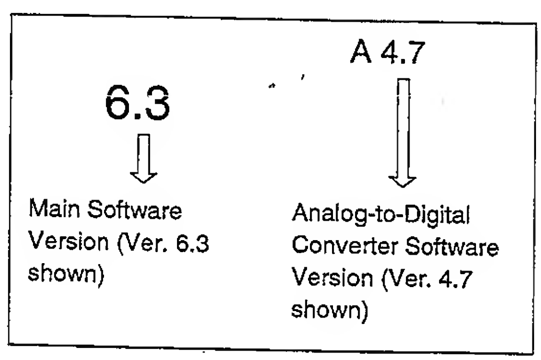
**Figure 2-21. Setting Date and Time**

## Reading Instrument Software Versions 2-27.

Perform the procedure in Figure 2-22 to view the version of the internal software that is controlling the instrument's operation. Two software versions are identified with this procedure: the main software that operates all instrument functions, and the analog-to-digital software that operates the instrument analog-to-digital converter.




**Reading the Software Versions.** Press the left and right arrow keys simultaneously to generate a display that shows the software versions in the following format:




Press the CANCL key to exit.

**Figure 2-22. Reading Instrument Software Versions**

## Returning to the LOCAL Mode 2-28.

Perform the procedure in Figure 2-23 to return the instrument from the remote mode to the local mode. When the instrument is operated over the RS-232 computer interface, the computer can disable all front panel controls except the SCAN key, which lights the REM annunciator (bright). If the REM annunciator is dim, the front panel keys are locked out (see Figure 2-24).


**Returning to the LOCAL Mode.** Press the SHIFT key to return instrument control from RS–232 computer interface control to front panel control. When the computer has control, the REM annunciator is on (bright) and only the SCAN key operates, triggering single scans. A return to LOCAL control is allowed at any time, even during scanning. (This assumes the RWLS computer command has not been invoked. See Section 4 for information on commands REMS, RWLS, and LOCS.)

**Figure 2-23. Returning to the LOCAL Mode**

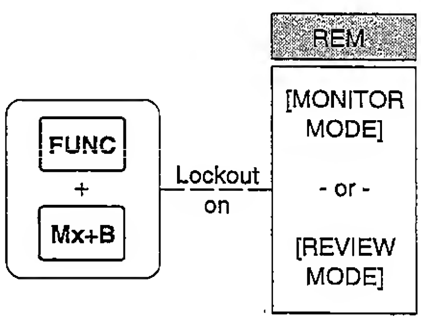
## Front Panel Key Lockout Options 2-29.

Perform the procedure in Figure 2-24 to lockout the front panel key functions. There are three lockout features:

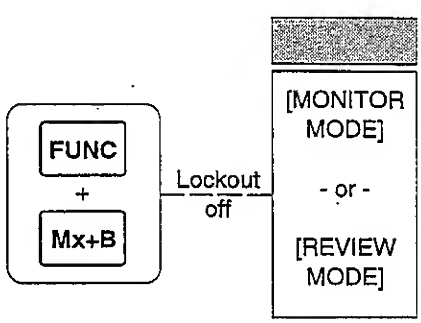
- Monitor Mode Lockout
- Review Mode Lockout

A third lockout can be enabled only from the computer interface (see LOCK 3 command in Section 4).

The Monitor Mode lockout is entered when the instrument is in the Monitor Mode; the Review Mode Lockout is entered when the instrument is in the Review Mode. When lockout is enabled, the instrument becomes "locked" in a selected mode preventing any unauthorized instrument operations. A repeat of the lockout keystrokes releases the lockout and the instrument resumes normal operation. When in the locked condition, the front panel REM indicator is on (dim). This feature allows inexperienced operators to use the instrument without having to change the mode of operation. The keystrokes used to enable or disable the lockout option is normally not revealed to unauthorized personnel.




**Lockout Enable.** Press the FUNC and Mx+B keys at the same time to lock out the front panel key functions appropriate to the selected mode. The REM (Remote) annunciator will light.




**Lockout Disable.** Press the FUNC and Mx+B keys at the same time to exit the lockout mode. The REM (Remote) annunciator will go off and normal key function will return.

**Figure 2-24. Front Panel Key Lockout Options**

## INSTRUMENT INTERFACES 2-30.

Front panel operations that involve interfacing with memory cards, PCs, printers, and modems are described in separate manual sections, as follows.

### Memory Card Interface 2-31.

The Memory Card Interface is described in detail in Section 3, "Memory Card Operations."

### RS-232 Computer Interface 2-32.

The Computer Interface is described in detail in Section 4, "Computer Operations."

### Using the RS-232 Computer Interface with a Printer 2-33.

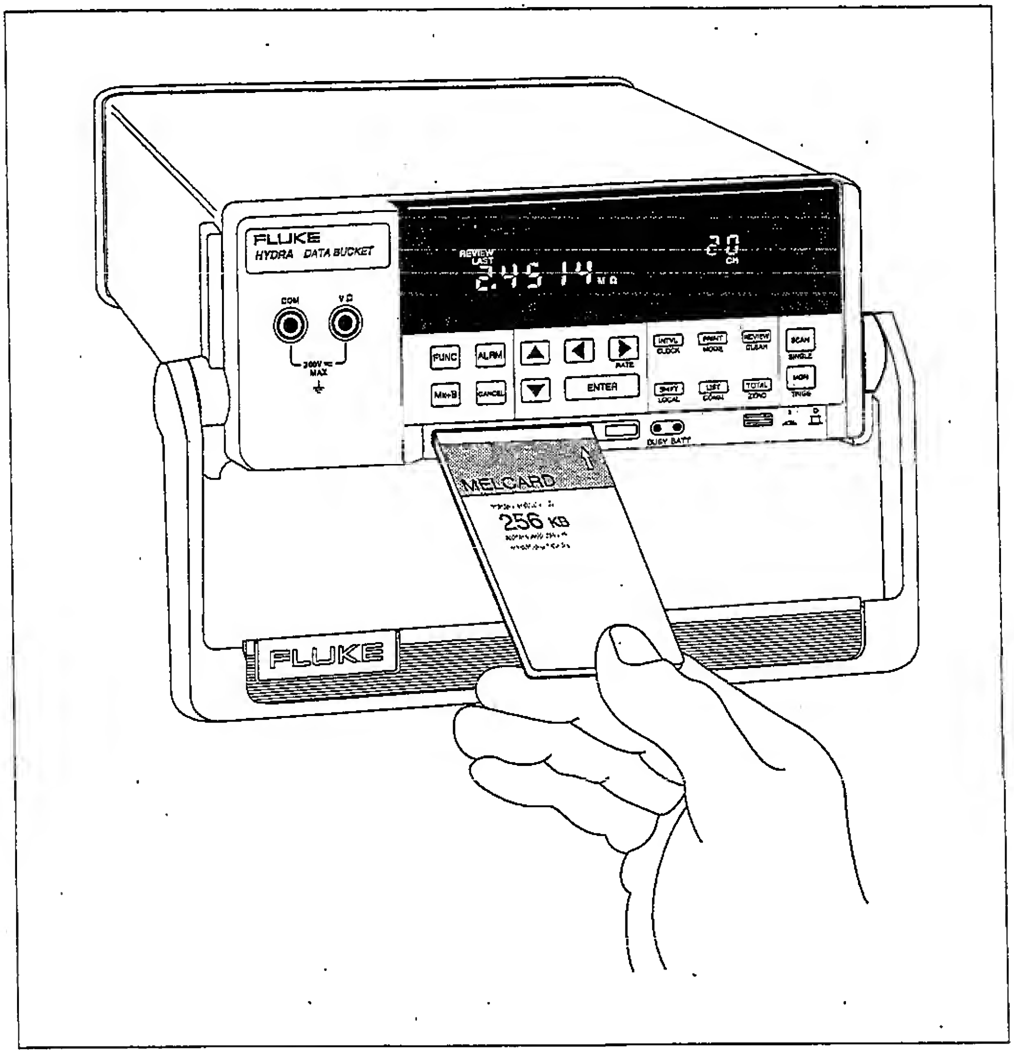
The Printer Interface is described in detail in Section 5, "Printer Operations."

### Using the RS-232 Computer Interface with a Modem 2-34.

The Modem Interface is described in detail in Section 6, "Modem Operations."

# Section 3
# Memory Card Operations

## CONTENTS


FLUKE
HYDRA DATA BUCKET
REVIEW
LAST
COM
FUNC
ALRM
Mx+B
CANCEL
ENTER
RATE
INTVL
CLOCK
PRINT
MODE
REVIEW
CLEAR
SCAN
SINGLE
MON
TRIGG
SHIFT
LOCAL
LIST
COMM
TOTAL
ZERO
BUSY BATT
MELCARD
256 KB
FLUKE

## SUMMARY OF MEMORY CARD OPERATIONS 3-1.

Memory card operations use a small, lightweight memory card (Figure 3-1) to save and load setup files (instrument configurations) and to record measurement data during scanning. The memory card consists of static random-access memory (SRAM) powered by an internal battery. Care should be taken not to drop or bend the card, and to keep it dry and away from high and low temperature extremes. Memory card operation is allowed in the same temperatures and humidity specifications that apply to the instrument (see Appendix A, "Specifications"). SRAM memory cards are readily available from supply houses serving the computer industry, or from Fluke (see Table 1-2, "Options and Accessories").

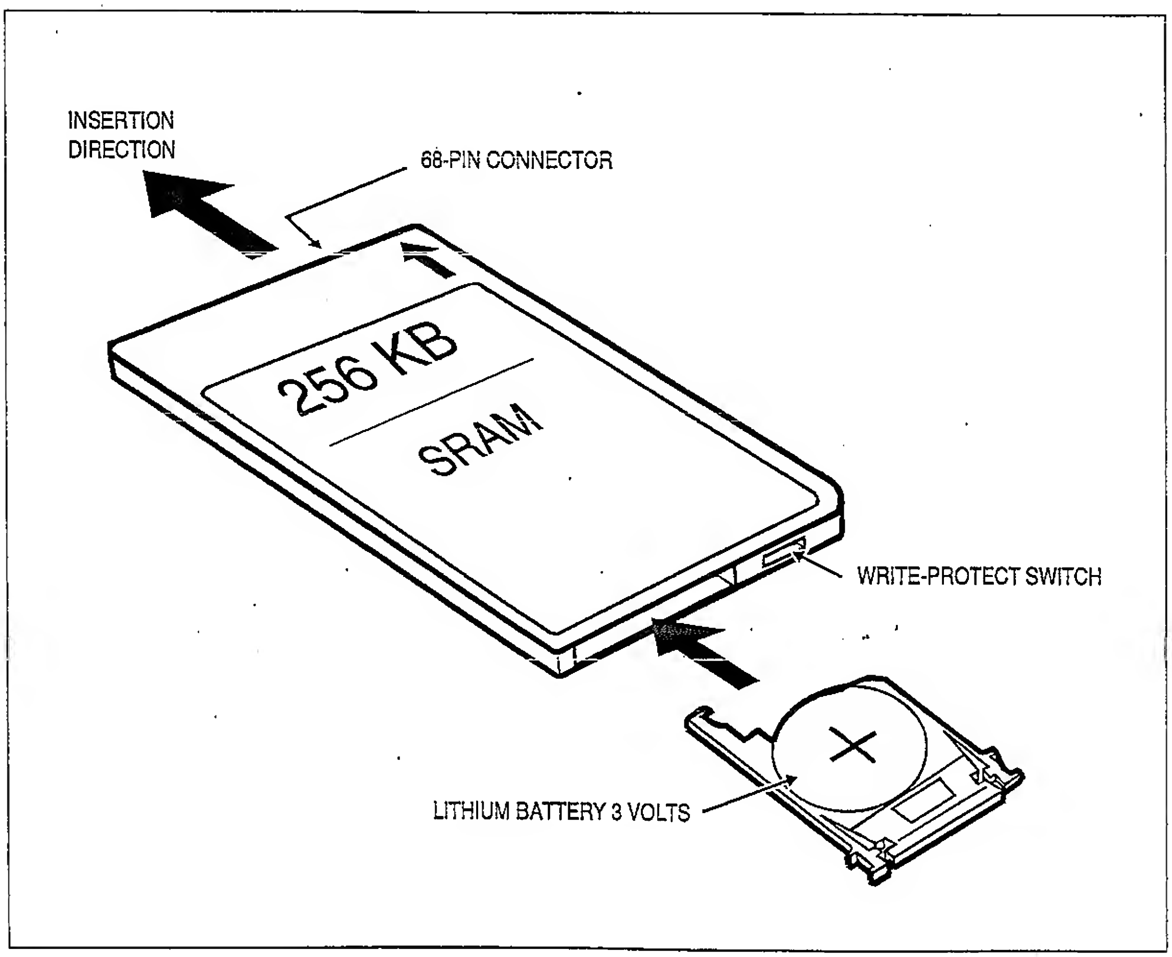



**Figure 3-1. Typical Memory Card**

## Memory Card Files 3-2.

Two types of memory card files are used. Files that store instrument configurations are setup files, SEtxx, and files that store measurement data are data files, dAtxx, where xx is an integer from 00 to 99. The number xx can be assigned by the instrument or selected by the operator. When the assigned integer reaches 99, previous integers available from erased files or numbers skipped over are reassigned for subsequent new files. The memory card can contain a maximum of 100 SEtxx and 100 dAtxx files.

### SETUP FILES

When the front panel controls have been used to configure channels for a particular instrument application, including type of measurement, alarms, scaling, rate, and all other operating parameters, this configuration can be saved as a SEtxx file. If this is the first setup file saved on the memory card, the instrument will assign 00 for the file name SEt00, or you can select your own file number. The instrument displays only the SEtxx portion, but all files are appended with the extension .HYD. Subsequent setup files would be SEt01, SEt02, and so on. The user should note the file name assigned or selected for a particular instrument configuration. A directory of card files are easily viewed and printed out using the directory feature (Figure 3-10). Setup files allow the entire instrument to be configured for an operation in an instant. The "Logger" applications software can be used to create setup files that are tagged with a user-defined string.

### DATA FILES

Data files, dAtxx, are opened automatically at scanning when the memory card is selected as a destination for measurement data. The display will indicate the file being opened. For example, pressing the SCAN key will display dAt00 (for the first data file on the memory card), which is acknowledged by pressing ENTER, and then the scanning begins. A file number can be selected as well. The instrument displays only the dAtxx portion, but all files are appended with the extension .HYD. If scanning is stopped, then resumed without changing instrument configuration or the memory card, the data will be appended to the opened file. If any parameter is changed or the memory card is changed, the next scan cycle will open a new dAtxx file. Extracting measurement data from the data files is accomplished by a PC running Starter or Logger applications software. The data is read to the PC from the memory card in the instrument, using an RS-232 link, or the memory card can be taken to a PC equipped with a memory card reader (optional – see Table 1-2, "Options and Accessories"). The PC Logger applications software allows separate data files to be edited and combined into a single file.

## Memory Card Capacity 3-3.

An empty 256K-byte memory card (supplied) will store 4,800 scans of ten channels; an empty 1M-byte memory card (optional) will store 19,800 scans of ten channels. SRAM memory cards are available in a variety of sizes. When scanning and recording data onto the memory card, the front panel indicates what percentage of the memory card has been used (Figure 3-2). For example, a display of 74Pct indicates 74% of the card has been used.

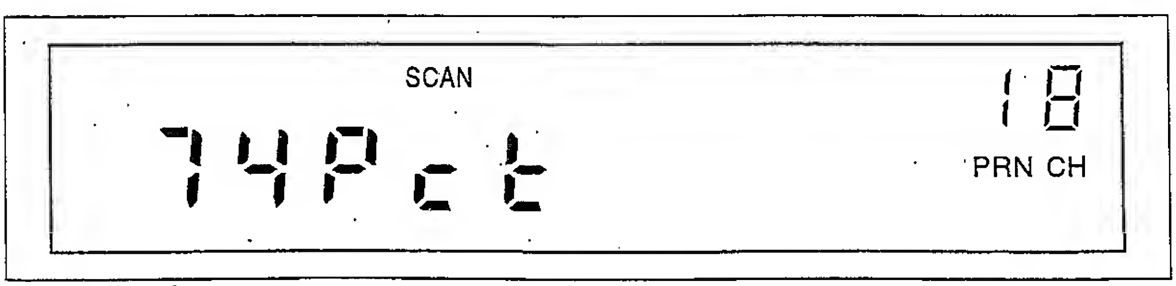



**Figure 3-2. Front Panel Memory Card Percent Display**

### Memory Card Battery 3-4.

A typical SRAM is powered by an internal lithium 3-volt battery that has a minimum life of five years for a 256K-byte card, and two years for a 1M-byte card. If the battery voltage falls below 2.75 volts, the front panel BATT indicator will light (see Figure 1-1). Battery life is reduced in applications with high ambient temperature.

## INSERTING AND REMOVING THE MEMORY CARD 3-5.

Memory card operations that involve inserting and removing the card are described below. Any illegal memory card operations result in an instrument double "beep" and an error message. Error messages are summarized in Table 3-1.

### Inserting a Memory Card 3-6.

To insert the memory card into the instrument, orient the card so the insertion-direction arrows are on top and point towards the card reader slot. Push the card at the center of the edge into the slot until resistance is noted, then firmly push until seated in the connector. If the instrument responds with a double beep and error message, the inserted card is unformatted (see the initialization procedure in Figure 3-3).

### Removing a Memory Card 3-7.

To remove the memory card from the instrument, press the ejection button to the right of the card (see Figure 1-1). The button should be pressed firmly until it becomes flush with the instrument front panel. This action ejects the card from the connector and pushes it free of the reader assembly. Grasp the card and remove from the instrument.

### Changing the Memory Card During Scanning 3-8.

When recording measurement data to a memory card that is nearly full (as noted by the percent indication), remove the memory card in the normal way when the BUSY indicator is off. Then insert a new memory card (be sure it is formatted), which will automatically open a file with the same number and continue recording data. For example, if scanning started with dAt17 on the original card, dAt17 will be opened on the replacement card. If the same filed already exists on the replacement card, e.g., dAt17, an error message appears. No data is lost during this operation as the instrument stores up to 75 scans when the memory card is removed during scanning, and the new memory card is immediately updated with this stored data. The PC software "Logger" allows separate memory card files to be combined into a single file.

### Setting the Memory Card Write-Protect Feature 3-9.

The memory card (Figure 3-1) has a write-protect switch that can be positioned to prevent the writing of data to the card, the erasing of any dAtxx or SEtxx file, or the initialization of the memory card. Normally, this switch is placed in the read/write position. However, if the card has critical data that should be protected, the switch is placed in the write-protect (read only) position.

## INSTALLING OR REPLACING THE MEMORY CARD BATTERY 3-10.

To install or replace the battery in the memory card, follow the instructions supplied with the memory card. A typical battery installation is shown in Figure 3-1. Memory card batteries are readily available from supply houses serving the computer industry (typically 3V dc, Panasonic BR2325, Maxell CR2025, or equal).

Table 3-1. Memory Card Error Codes

| ERROR | PROBABLE CAUSE | REMEDY |
|---|---|---|
| Err 1 CArd | CARD ERROR - Unable to use a card (Note 1): | |
| | Card is missing or card is not fully inserted. | Install a memory card (Fig. 3-1). |
| | Card is unformatted. | Initialize memory card (Fig. 3-3). |
| | Write-protect switch in the read-only position. | Reposition switch (Fig. 3-1). |
| | Card is 100% full of data. | Erase files (Fig. 3-7/3-9) or use another card. |
| Err 2 FILE | FILE ERROR - Unable to open a file (Note 1): | |
| | The selected file name already exists. | Chose another file name (Fig. 3-5/3-8) or erase files (Fig. 3-7/3-9). |
| | All file names are assigned (SEt00 SEt99 or dAt00 to dAt99). | Erase files (Fig. 3-7/3-9) or use another card. |
| Err 3 bAd | CARD PROBLEM (Scans Saved) (Note 1): | |
| | Card exchanged during scanning is unformatted. | Use a formatted card (Note 2). |
| | Card exchanged during scanning is full of data. | Use a different card (Note 2). |
| | Replacement card has a duplicate file name. (Note 4). | Use a different card (Note 2). |
| Err 4 bAd | CARD PROBLEM (Scans Lost) (Note 1): | |
| | Same as Err 3 bAd (Note 3). | |
| Err 3 FULL | CARD IS FULL (Scans Saved) (Note 1): | |
| | Card is 100 % full of data. | Use a different card (Note 2). |
| Err 4 FULL | CARD IS FULL (Scans Lost) (Note 1): | |
| | Same as Err 3 FULL (Note 3). | |

Note 1: Err 1 and Err 2 are non-scanning errors that occur only before scanning starts. Err 3 and Err 4 are scanning errors that occur only after scanning starts.

Note 2: Err 3 indicates scans are being saved in an internal memory (75 scans) while the memory card error is being resolved. Err 4 indicates scans are being lost because the internal memory overflowed (75 scans) before the error was corrected. When a suitable exchange card is inserted, the internal memory updates the card with the stored scans.

Note 3: When memory cards are exchanged during scanning and the replacement card has a problem, Err 3/Err 4 is appended with the word bAd. When the memory card used for scanning becomes full of data, Err 3/Err 4 is appended with the word FULL.

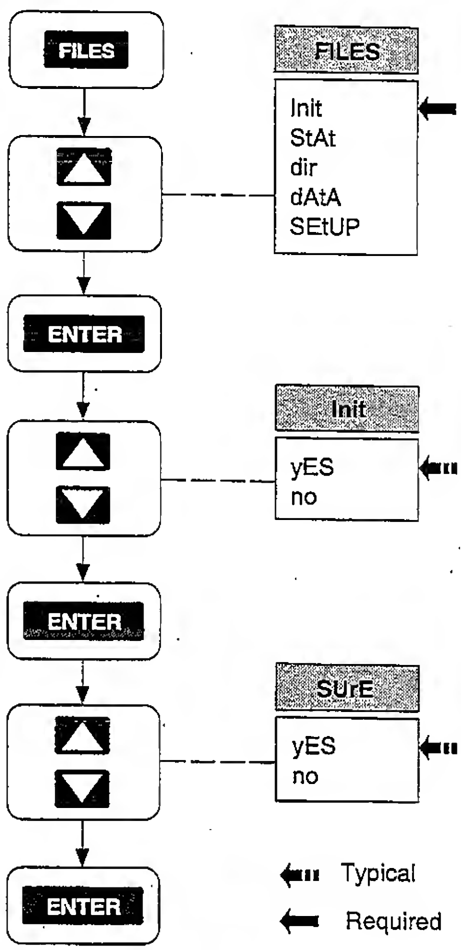
Note 4: When memory cards are exchanged during scanning, the replacement card must have the same file name available as was used for the original scan. If this file name already exists on the replacement card, an Err 3/Err 4 will occur.

## INITIALIZING A MEMORY CARD 3-11.

Perform the procedure in Figure 3-3 to initialize (format) a memory card. Memory cards can also be formatted at a PC if it is equipped with a memory card reader. (Formatting at a PC uses the format utility supplied with the memory card reader.) When the memory card is formatted, a standard DOS file system and directory are put into the memory on the card. To exit at any time (formatting not completed), press the CANCL key.

*NOTE*

*Any scan data that may be stored in the internal memory waiting to be written to a valid memory card (see paragraph 3-8 Changing the Memory Card During Scanning) will be lost when formatting a memory card.*




**Selecting the INITIALIZATION mode.** Insert the memory card to be initialized. Press the FILES key to access the FILES menu. Press the up/down arrow keys until Init is displayed, then press the ENTER key. The menu changes to Init. If an error message appears, see Table 3-1.

**Verifing the INIT mode.** To verify the selection of the initialization mode, press the up/down arrow keys until yES is displayed in the Init menu, then press the ENTER key. To exit the procedure, select no and then press the ENTER key. If yES is selected, the menu changes to SUrE.

**Initializating the memory card.** Press the up/down arrow keys to select yES or no in the SUrE menu, then press the ENTER key. "yES" will initialize the memory card, erasing all previous data (if any); "no" cancels the procedure. If Err 1 CArd appears, the small switch on the card may be in the write-protect position. Reposition the switch and repeat this procedure.

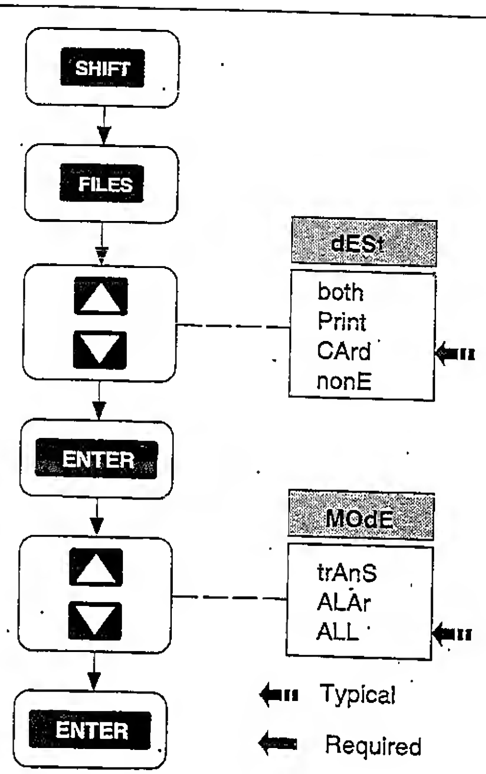
Figure 3-3. Initializing a Memory Card

## RECORDING MEASUREMENT RESULTS DURING SCANNING 3-12.

Perform the procedure in Figure 3-4 to record measurement results onto the memory card. The destination for the scanned data can be the memory card, printer, both the memory card and printer, or no destination, where the results are not saved, except in the Review array (last, maximum, and minimum scanned values) and in the 100-scan internal memory FIFO (First In First Out) log queue. (The internal memory log queue is accessed only through the computer interface. See Section 4, "Computer Operations.") The mode for recording to the memory card or printer can be all scanned data, scanned data only when any scanned channel is in alarm, or single scans when an alarm transitions into or out of alarm.

*NOTE*

*Measurement results recorded onto a memory card are extracted only by a PC running the Starter or Logger applications software. If printed results are desired as well as recording to the memory card, then "both" must be selected in the procedure below and a printer must be connected to the RS-232 port. See Section 5, Printer Operations, for more information.*




**Setting the DESTINATION Parameter.** Press the SHIFT key, release, then press the FILES key to open the destination menu. Select both (Both) to route measurement data to both the memory card and printer; select Card (Card) to route measurement data just to the memory card.

**Selecting the Destination MODE.** The destination mode determines when the memory card should record. Select trAns (Transition) to record one complete scan when a channel has transitioned into or out of an alarm limit. Select ALAr (Alarm) to record all channel scans while any channel is in an alarm condition (stopping when all channels are out of alarm). Select ALL (All) to record all scans.

**Figure 3-4. Recording Measurement Results During Scanning**

## SETUP FILE PROCEDURES

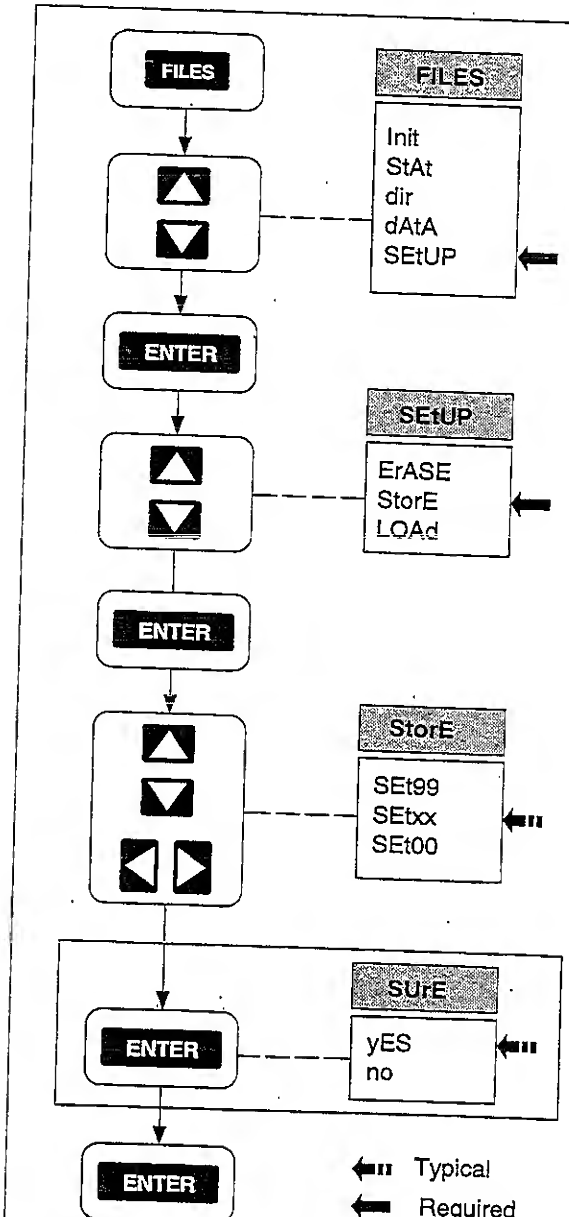
3-13.

Perform the following procedures to LOAD, STORE, and ERASE memory card instrument configuration (SEtUP) files.

### Using SETUP STORE

3-14.

Perform the procedure in Figure 3-5 to save the current instrument configuration. The communication parameters: baud, parity, CTS, and echo, remain as set previously by the front panel controls or computer interface. The instrument automatically assigns the next sequential SExx file name. When SEt99 is reached, the instrument loops back to reuse previously assigned file names that have been erased or skipped over. To assign your own file name, use the up/down and left/right arrow keys when creating the file.




**Selecting the SETUP mode.** Press the FILES key to access the FILES menu. Press the up/down arrow keys until SEtUP is displayed, then press the ENTER key. The menu changes to SEtUP. If an error message appears, see Table 3-1.

**Selecting the STORE mode.** Press the up/down arrow keys until StorE is displayed in the SEtUP menu, then press the ENTER key. The menu changes to StorE and a file name is displayed.

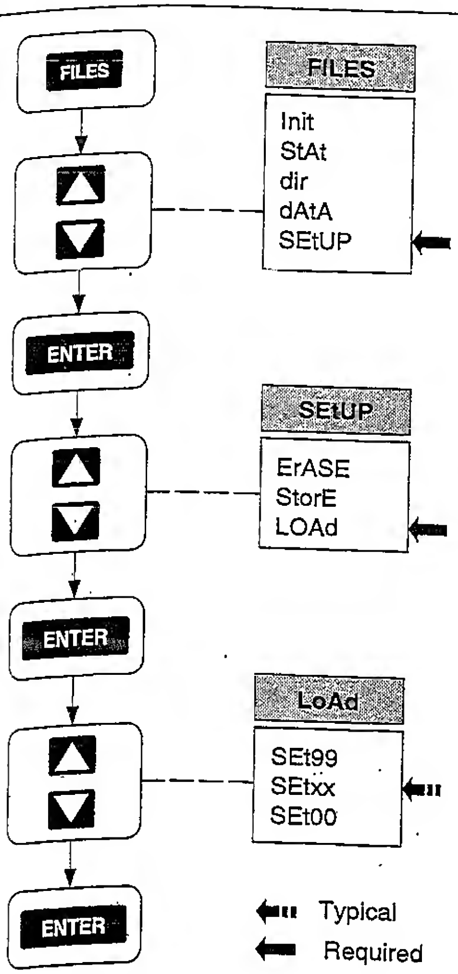
**Storing a SEtxx File.** Record the displayed SEtxx file name, where xx represents an instrument-assigned number between 00 and 99 or use the up/down, left/right arrow keys to select the xx number. Press the ENTER key to store the file.

**Overwriting a SEtxx File.** If the xx number selected in the previous step is already assigned, the existing file will be overwritten with the new file. If this is desired, select yES then press the ENTER key. If no is selected, the procedure will terminate. If an error message appears, see Table 3-1.

Figure 3-5. Using SETUP STORE to Save Configuration Files

## Using SETUP LOAD 3-15.

Perform the procedure in Figure 3-6 to discard the current instrument configuration and load a configuration saved in a previous SETUP STORE operation (Figure 3-5). A configuration file includes channel configurations, scan interval, measurement rate, alarms, Mx+B scaling, and temperature unit (°C or °F). Communication parameters, baud, parity, CTS, and echo remain as set previously by the front panel controls. To exit at any time (file not loaded), press the CANCL key.




**Selecting the SETUP mode.** Press the FILES key to access the FILES menu. Press the up/down arrow keys until SEtUP is displayed, then press the ENTER key. The menu changes to SEtUP. If an error message appears, see Table 3-1.

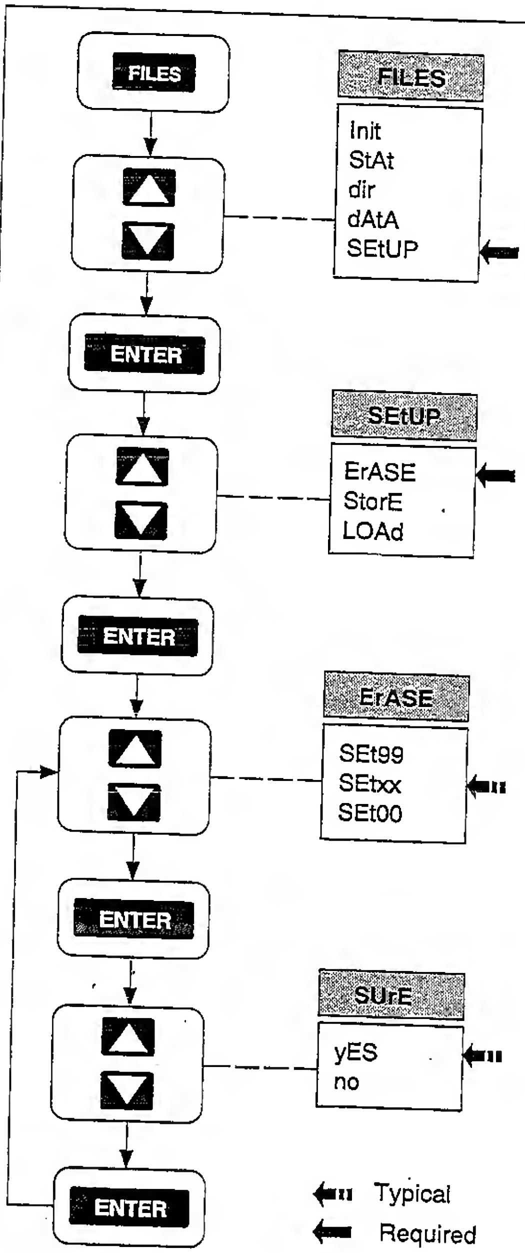
**Selecting the LOAD mode.** Press the up/down arrow keys until LoAd is displayed in the SETUP menu, then press the ENTER key. The menu changes to LoAd.

**Selecting a SExx File to LOAD.** Press the up/down arrow keys until the SEtxx file to be loaded is displayed in the LoAd menu, where xx represents a number from 00 to 99, then press the ENTER key. After ENTER is pressed, the entire meter configuration changes to reflect the data stored in the selected SETUP file. A display of nonE indicates no setup files are stored.

**Figure 3-6. Using SETUP LOAD to Load Configuration Files**

## Using SETUP ERASE 3-16.

Perform the procedure in Figure 3-7 to remove a setup file from the memory card. Removing a file does not interrupt the sequential SEtxx file names assigned with the SEtUP STORE command. When SEt99 is reached, the instrument loops back to reuse previously assigned file names that have been erased or skipped over. To exit at any time (file not erased), press the CANCL key.




**Selecting the SETUP mode.** Press the FILES key to access the FILES menu. Press the up/down arrow keys until SEtUP is displayed, then press the ENTER key. The menu changes to SEtUP. If an error message appears, see Table 3-1.

**Selecting the ERASE mode.** Press the up/down arrow keys until ErASE is displayed in the SEtUP menu, then press the ENTER key. The menu changes to ErASE.

**Selecting a SEtxx File to ERASE.** Press the up/down arrow keys until the SEtxx file to be erased is displayed in the ErASE menu, where xx represents a number from 00 to 99, then press the ENTER key. The menu changes to SUrE.

**Erasing a SEtxx File.** Press the up/down arrow keys to select yES or no in the SUrE menu, then press the ENTER key. yES will erase the file, no will cancel the procedure and nothing will be erased. The procedure repeats after pressing ENTER, or displays nonE if there are no files to erase. Press the CANCL key to exit. If an error message occurs, see Table 3-1.

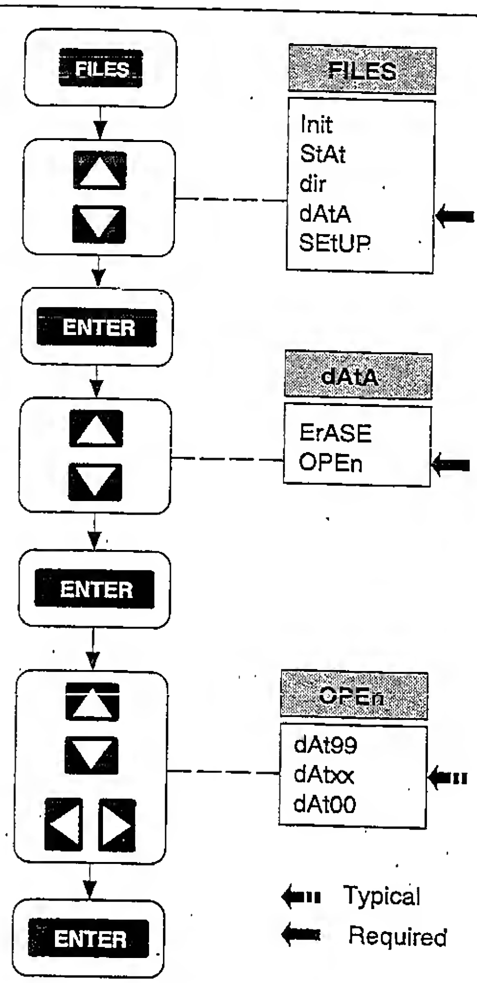
**Figure 3-7. Using SETUP ERASE to Delete Configuration Files**

## DATA FILE PROCEDURES 3-17.

Perform the following procedures to OPEN, LOAD, STORE, and ERASE memory card instrument data (DATA) files.

## Using DATA OPEN 3-18.

Perform the procedure in Figure 3-8 to open a data file in preparation for recording measurement data to the memory card. This procedure is automatically invoked if the SCAN key is pressed and the instrument is configured for memory card operations. The instrument automatically assigns the next sequential dAtxx file name. To assign your own file name, use the up/down and left/right arrow keys when creating the file. When dAt99 is reached, the instrument loops back to reuse previously assigned file names that have been erased or skipped over. Data cannot be appended to an existing file, except in the case where scanning is turned off and on without changing the instrument configuration. Before using the DATA OPEN command, verify the instrument is configured for measurement. If a file is opened and then the instrument configuration is changed, the file will automatically be closed.




**Selecting the DATA mode.** Press the FILES key to access the FILES menu. Press the up/down arrow keys until dAtA is displayed, then press the ENTER key. The menu changes to dAtA. If an error message appears, refer to Table 3-1.

**Selecting the OPEN mode.** Press the up/down arrow keys until OPEn is displayed in the dAtA menu, then press the ENTER key. The menu changes to OPEn and a file name is displayed.

**Opening a dAtxx File.** Record the displayed dAtxx file name, where xx represents an instrument-assigned number from 00 to 99. Or use the up/down, left/rightarrow keys to select the xx number. Press the ENTER key to open the file. If an error message appears, see Table 3-1.

The "dESt" menu appears if a dAtxx file is opened and the memory card is not selected as a data destination (see Figure 3-4).

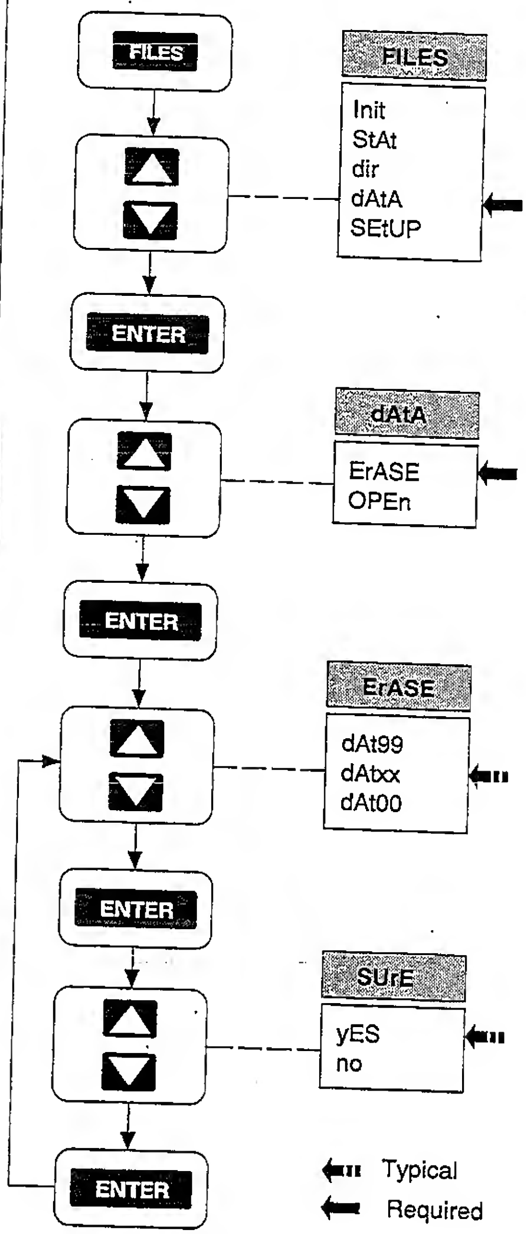
**Figure 3-8. Using DATA OPEN to Save Measurement Data in a File**

## Using DATA ERASE 3-19.

Perform the procedure in Figure 3-9 to remove a data file from the memory card. Removing a file does not interrupt the sequential dAtxx file names assigned with the DATA OPEN command. When dAt99 is reached, the instrument will loop back and reuse previously assigned file names that have been erased or skipped over. To exit at any time (file not erased), press the CANCL key.

NOTE

*When erasing a data file that is currently open for recording measurement data, any scan data stored in internal memory waiting to be written to the file will be lost. This may occur, for instance, if the memory card became full during scanning (see Table 3-1 Memory Card Error Codes).*




**Selecting the DATA mode.** Press the FILES key to access the FILES menu. Press the up/down arrow keys until dAtA is displayed, then press the ENTER key. The menu changes to dAtA. If an error message appears, see Table 3-1.

**Selecting the ERASE mode.** Press the up/down arrow keys until ERASE is displayed in the dAtA menu, then press the ENTER key. The menu changes to ErASE.

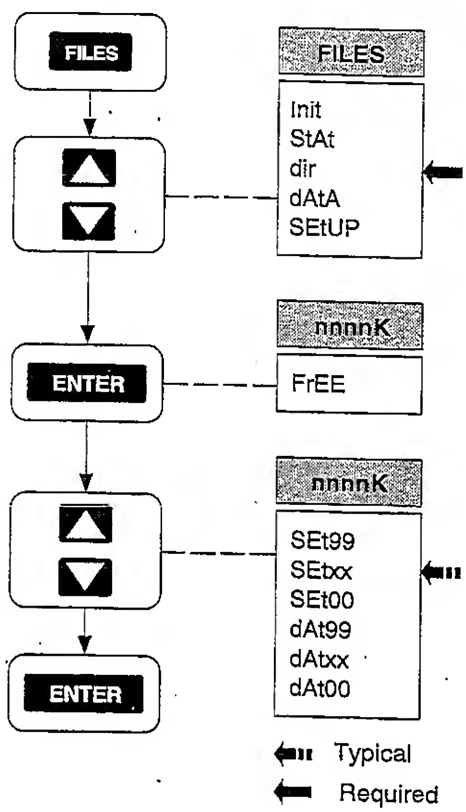
**Selecting a dAtxx File to ERASE.** Press the up/down arrow keys until the dAtxx file to be erased is displayed in the ErASE menu, where xx represents a number from 00 to 99, then press the ENTER key. The menu changes to SUrE.

**Erasing a dAtxx File.** Press the up/down arrow keys to select yES or no in the SUrE menu, then press the ENTER key. yES will erase the file; no will cancel the procedure and nothing will be erased. The procedure repeats after pressing ENTER, or displays nonE if there are no files to erase. Press the CANCL key to exit. If an error message occurs, see Table 3-1.

**Figure 3-9. Using DATA ERASE to Delete a Measurement Data File**

## SETUP AND DATA FILES DIRECTORY 3-20.

Perform the procedure in Figure 3-10 to obtain a directory of existing SEtxx files and dAtxx files that exist on the memory card, plus the remaining capacity of the card. The size of the selected file is given in the front panel display in K-bytes. To exit at any time (directory not completed), press the CANCL key.




**Selecting the DIRECTORY mode.** Press the FILES key to access the FILES menu. Press the up/down arrow keys until dir is displayed, then press the ENTER key. The menu changes to nnnnK, where nnnn represents a number of kilobytes. If an error message appears, see Table 3-1.

**Viewing the Available Memory Card Capacity.** The bytes available on the memory card are displayed first as an overall directory summary.

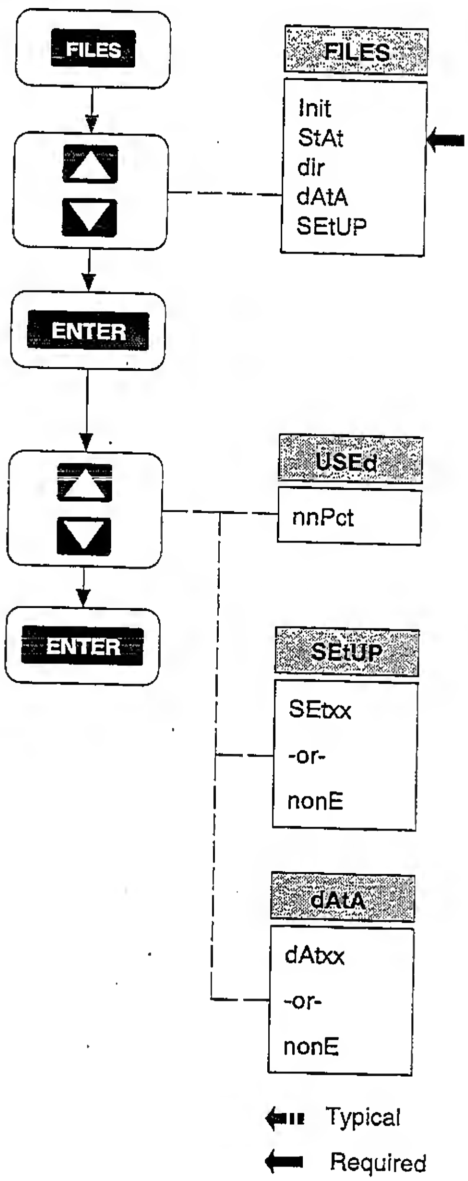
**Viewing the files.** To view the size of the individual files, press the up/down arrow keys until the desired SEtxx or dAtxx file is displayed, where xx presents the file identification number from 00 to 99. The size of the selected file, in kilobytes, is displayed. When directory operations are complete, press the ENTER key.

**Figure 3-10. Using DIRECTORY to Examine SETUP and DATA Files**

## SETUP AND DATA FILE CURRENT STATUS

**3-21.**

Perform the procedure in Figure 3-11 to display the status of the memory card SEtxx and dAtxx files that are currently in effect or were in effect for the most recent scan. The xx portion of the file name represents a file identification number from 00 to 99.




**Selecting the STATUS mode.** Press the FILES key to access the FILES menu. Press the up/down arrow keys until StAt is displayed, then press the ENTER key.

**Status of the Memory Card.** The percent of the capacity of the memory card that has been used is shown, where nn represents a number from 00 to 99. If no memory card is installed, the display is --Pct.

**Status of the SEtxx File.** The setup file that was in effect for the most recent scan is shown, where xx represents a file number from 00 to 99. If no setup file was open, nonE is displayed.

**Status of the dAtxx File.** The data file that was open for the most recent scan is shown, where xx represents a file number from 00 to 99. If no data file was open, nonE is displayed.

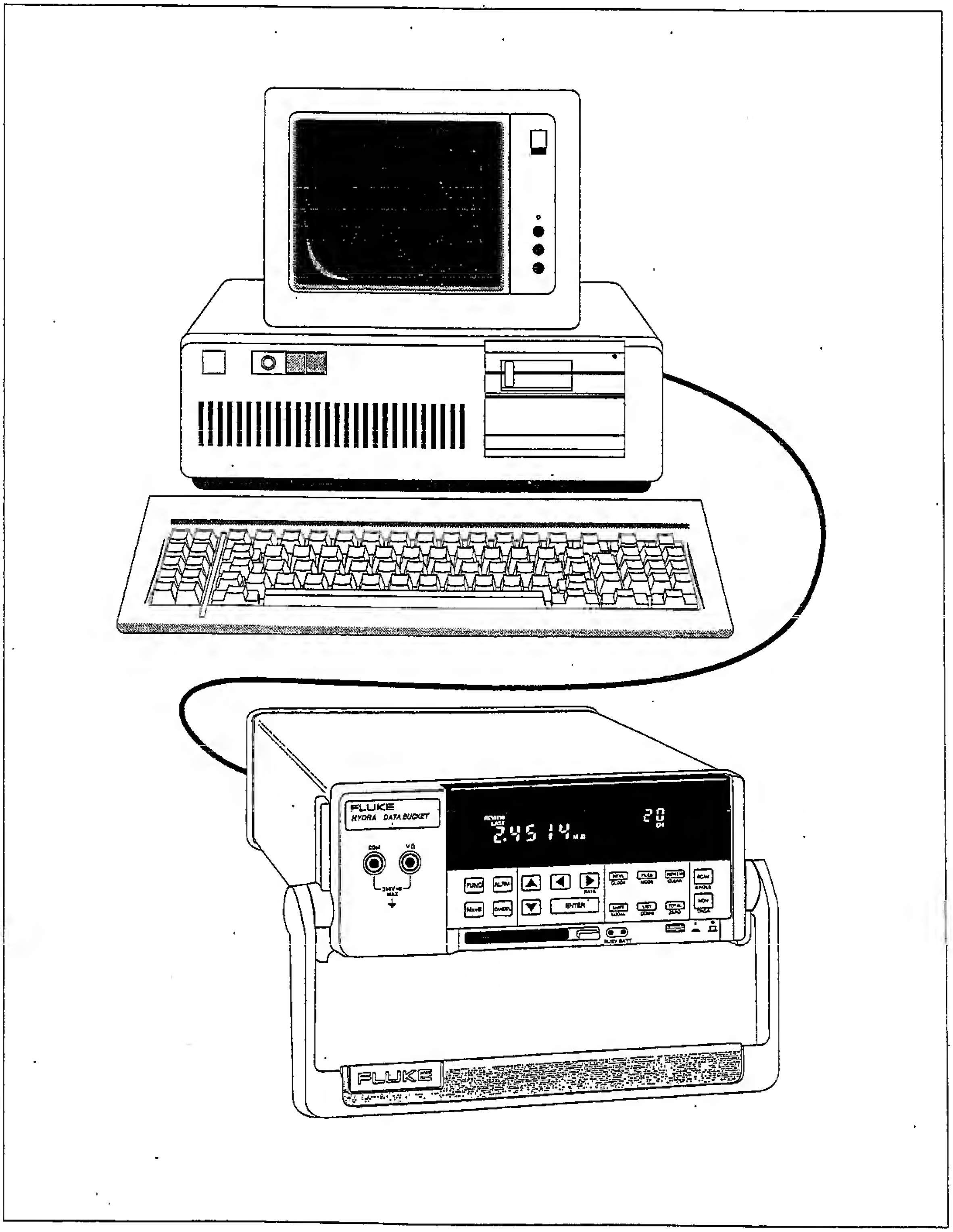
**Figure 3-11. Using STATUS to Examine SETUP and DATA Files**

## MEMORY CARD FILE OPERATIONS TO AND FROM A PC 3-22.

All memory card file transfers to and from the instrument are controlled at the PC. Nothing is required at the instrument end, except to have the RS-232 link operating correctly (see Section 4, "Computer Operations") and having the desired memory card installed in the instrument front panel. Refer to the applications software documentation supplied with Starter (supplied) or Logger (optional).

## Section 4
# Computer Operations

### CONTENTS


FLUKE
HYDRA DATA BUCKET
ENTER
FLUKE

## SUMMARY OF COMPUTER OPERATIONS 4-1.

Computer operations allow the instrument to be configured and controlled from a personal computer (PC), including data exchanges with the instrument memory card. The computer interface is via an RS-232 link between the instrument RS-232 port and a PC serial COM port. The PC gives operation and configuration commands to the instrument, and the instrument returns status signals (alarms, for example) and scan measurement data. PC operations can be in real time with a dedicated RS-232 connection, or the instrument can be connected to a PC for configuration and then removed for distant operations. Memory Card features are described in Section 3, Memory Card Operations.

PC applications software Hydra Starter Package (Starter) and Hydra Logger Package (Logger) (optional) operate the RS-232 computer interface. The software packages are described in separate technical manuals; however, each accomplishes the following:

| | |
|---|---|
| Starter (supplied) | Starter is a menu-driven software package used to transfer configuration data from and to the instrument, log measurement data collected by the instrument, and manage the acquired data. |
| Logger (optional) | Logger has all the features of Starter plus a trend plot display (with proper PC display capability), strip-chart printer plot (with graphics compatible printer), and the ability to operate two instruments at a time. |

Custom software can be developed by the user in GWBASIC, Quick BASIC (QBASIC), or Quick C using the computer interface command set, which is described in this section.

The RS-232 computer interface between a instrument and a PC is discussed in the following paragraphs in this sequence:

- Connecting the Instrument to a PC
- Configuring the Instrument for Computer Operations
- Configuring the PC for Computer Operations
- Testing the Instrument/PC RS-232 Interface
- Computer Interface Commands and Operation

## CONNECTING THE INSTRUMENT TO A PC 4-2.

The two most common configurations for connecting the instrument to a PC are shown in Figure 4-1. The instrument RS-232 port (DB-9 connector) is cabled to a PC serial COM port that uses either a DB-9 connector or DB-25 connector. The connecting cable can be fabricated (see Appendix E) or ordered from Fluke as an option (see Section 1).

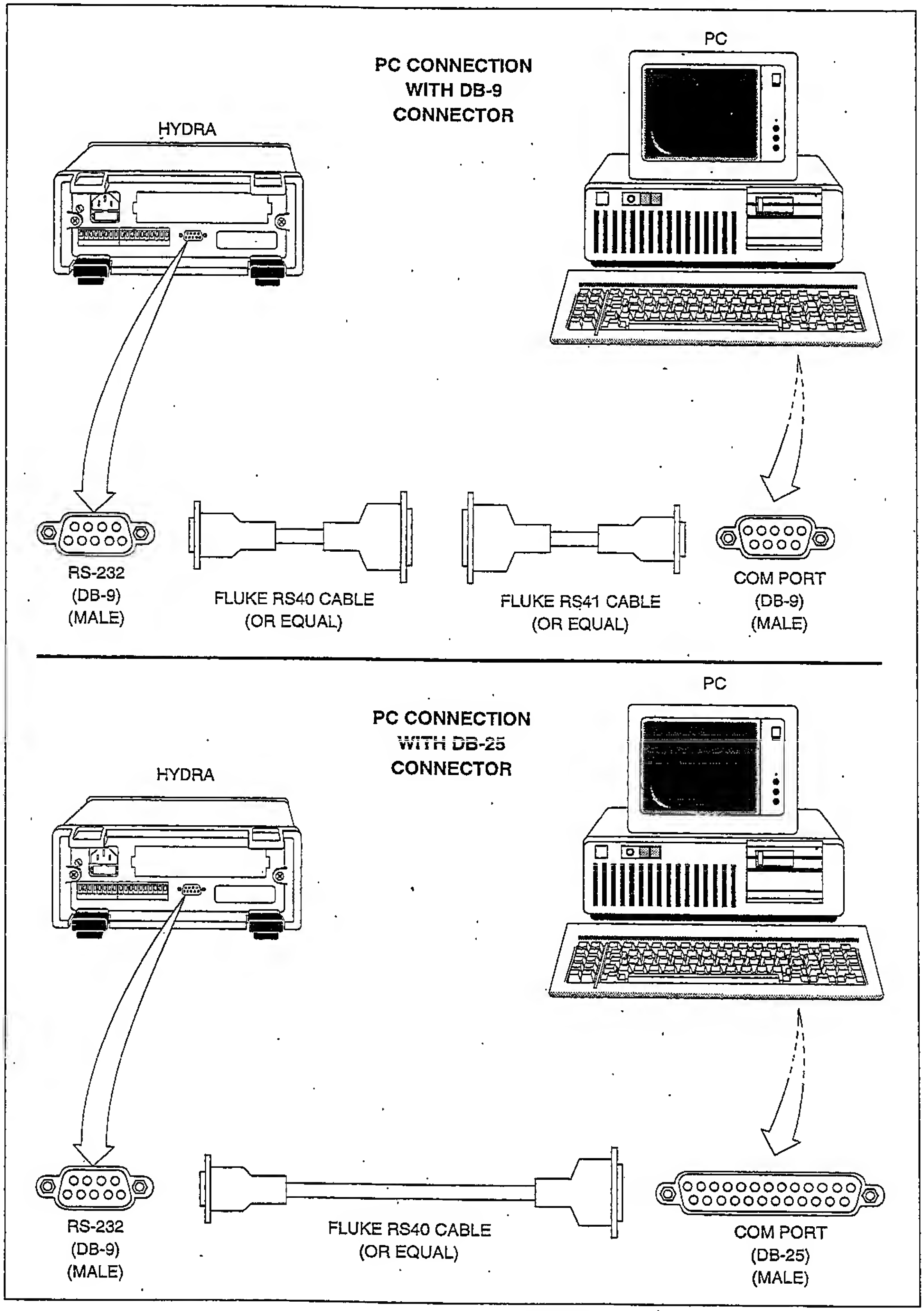
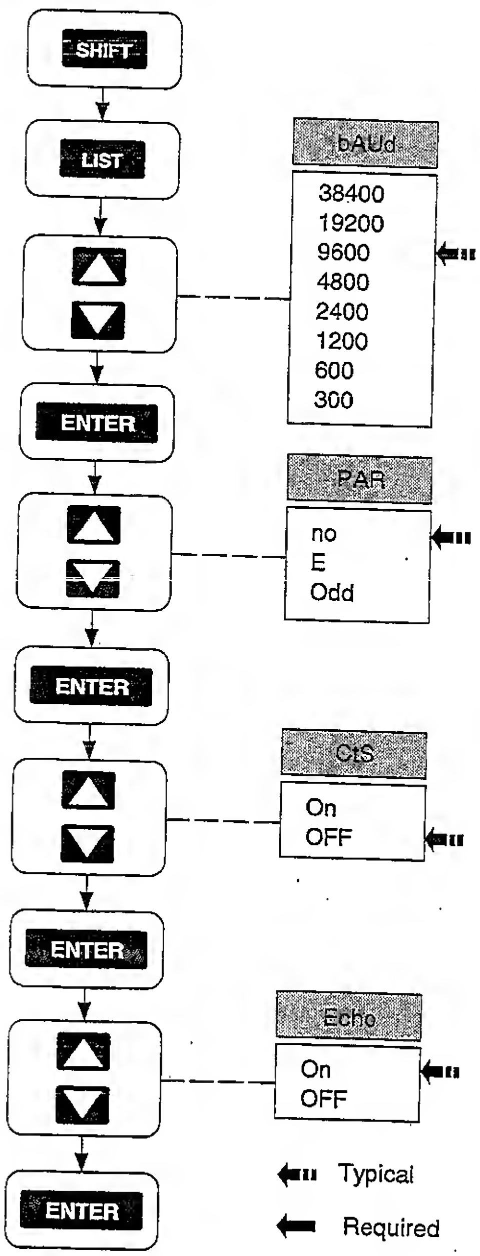



**Figure 4-1. Connecting the Instrument to a PC**

## CONFIGURING THE INSTRUMENT FOR COMPUTER OPERATIONS 4-3.

Correct operation of the interface between the instrument and PC depends on the baud rate, parity, CTS (Clear To Send) and echo of the RS-232 interface parameters. Perform the procedure in Figure 4-2 to establish these parameters for the instrument. The instrument uses one stop bit, which is not selectable.




**Selecting the bAUd (Baud) Rate.** Press the SHIFT key, release, and then press the LIST key to open the communications parameters menu. The baud rate sets the rate of data transfer between the instrument and the PC. Normally, the highest compatible rate is selected. Select the rate using the up/down arrow keys, then press ENTER.

**Selecting PAR (Parity).** The 8th bit of a character can be set to make all characters odd (Odd) or even (E), or no parity at all (no). The computer checks parity (if selected) and indicates when an error is detected. Select the parity then press ENTER.

**Selecting CtS (Clear To Send).** The RS-232 CTS line (pin 8) is an input hardware control line derived from the PC Request to Send (RTS) line. When CTS is asserted, the instrument is allowed to transmit data. If the PC RS-232 interface does not have or use an RTS line, select OFF then press ENTER.

**Selecting Echo.** When echo is On, each character sent to the instrument is "echoed" back to the PC. The applications software Starter and Logger automatically turn echo OFF. The primary use of Echo On is for operations with a terminal emulator. Select the Echo parameter then press ENTER.

**Figure 4-2. Configuring the Instrument for Computer Operations**

## CONFIGURING THE PC FOR COMPUTER OPERATIONS 4-4.

Operation of the instrument from a PC always involves software, either software supplied with the instrument (Starter) or software developed by the user (GWBASIC, QBASIC or Quick C). Since the PC COM port is set up by the operating software, there is no separate configuration procedure.

## TESTING THE INSTRUMENT/PC RS-232 INTERFACE 4-5.

The RS-232 link between the instrument and PC should be tested before it is used for communications. Since DOS commands cannot test the link, some form of software control is required. Four procedures are provided:

- Testing using terminal emulation (Windows)
- Testing using terminal emulation (Generic)
- Testing using commands while in GWBASIC
- Testing using commands while in QBASIC

The RS-232 computer interface can also be tested using the TERM (Terminal) mode in both Starter and Logger applications software. Refer to the technical manuals supplied with the software for the test procedures.

### Testing the RS-232 Interface Using Terminal Emulation (Windows) 4-6.

Complete the procedure below to test the RS-232 link between the PC and instrument using the PC Windows terminal emulator. Identify the PC COM port used for the RS-232 link (COM1 is assumed).

1. Configure the Data Bucket communication parameters, as described in Figure 4-2, for bAUd = 9600, PAR = no, CtS = OFF, and Echo = On.
2. Turn on the PC, start Windows, open the Accessories menu and select Terminal.
3. Open the Terminal Settings menu and select Communications.
4. In Communications, select the following, then use OK to exit to Terminal:

   | | |
   |---|---|
   | Connector COM1 | [Typical] |
   | Baud Rate 9600 | |
   | Data Bits | 8 |
   | Stop Bits | 1 |
   | Parity | None |
   | Flow Control | None |

5. In Terminal, request the Data Bucket to send its identification number by entering: `*IDN? <Enter>` If `*IDN?` did not appear on the screen as the characters were entered, be sure the instrument RS-232 port is configured for Echo = On (Figure 4-2). If the wrong characters appear, there is an incompatibility in the COM port configurations (baud rate, parity, etc.). If everything seems normal, but characters still don't appear, check the RS-232 connection cable (see Appendix E). When the RS-232 link is operating correctly, the instrument returns an identification string and execution prompt similar to the following:

   ```
   FLUKE,2635A,0,Mn.n An.n Dn.n Ln.n
   =>
   ```

   `Mn.n` identifies the main software version.
   `An.n` identifies the analog-to-digital converter software version.
   `Dn.n` identifies the display software version.
   `Ln.n` identifies the programmable gate-array configuration version.

6. Other commands can be entered from the PC to gain familiarity with the instrument command set. All commands are summarized in Table 4-4 and explained in Table 4-5.

   For example: to reset the instrument, configure channel 0 to measure volts dc using the 300V DC scale (scale 4), send scan results to the RS-232 port, and scan once, enter the following:

   `*RST` [Resets the instrument (which does not affect the communication parameters)]
   `=>`
   `FUNC 0, VDC, 4` [Set channel 0 to volts dc and scale 4 (300V DC)]
   `=>`
   `PRINT_TYPE 0,0` [Sets the data destination as the RS-232 port, and all data]
   `=>`
   `PRINT 1` [Enables data logging to the RS-232 port]
   `=>`
   `*TRG` [Triggers a single scan]
   `=>`

   ```
   15:17:04  07/21/94
    0:   000.00 VDC
   ALM:15  DIO:255  TOTAL:0
   ```

   To decode the printout, see Figure 5-3.

   The commands in the above example can be combined into a single entry by using the semicolon separator character:

   `*RST;FUNC 0,VDC,4;PRINT_TYPE 0,0;PRINT 1;*TRG.`

7. One of the following three possible prompts are returned when a command is sent to the instrument:

   `=>` The command was executed [Example, `PRINT 1`].

   `!>` The command was recognized, but not executed [Example, `PRINT 3`, where only `PRINT 0` and `PRINT 1` are legal entries].

   `?>` The command wasn't recognized [Example, `PRITN 1`, spelling error].

8. Exit Windows and return to DOS, as required.

## Testing the RS-232 Interface Using Terminal Emulation (Generic) 4-7.

Complete the procedure below to test the RS-232 link between the PC and instrument using a generic terminal emulator. Refer to the documentation appropriate to the selected communications/terminal emulation software, as required. Identify the PC COM port used for the RS-232 link (COM1 is assumed).

1. Configure the Data Bucket communication parameters, as described in Figure 4-2, for bAUd = 9600, PAR = no, CtS = OFF, and Echo = On.
2. Turn on the PC, start the communications software, and open the COM port configuration screen.
3. Select the following communications parameters

   Connector COM1 [Typical]
   Baud Rate 9600
   Data Bits 8
   Stop Bits 1
   Parity None
   Flow Control None [May be called the RTS/CTS line]

4. In Terminal, request the Data Bucket to send its identification number by entering: `*IDN? <Enter>`. If `*IDN?` did not appear on the screen as the characters were entered, be sure the instrument RS-232 port is configured for Echo = On (Figure 4-2). If the wrong characters appear, there is an incompatibility in the COM port configurations (baud rate, parity, etc.). If everything seems normal, but characters still don't appear, check the RS-232 connection cable (see Appendix E). When the RS-232 link is operating correctly, the instrument returns an identification string and execution prompt similar to the following:

   ```
   FLUKE,2635A,0,Mn.n An.n Dn.n Ln.n
   =>
   ```

   `Mn.n` identifies the main software version.
   `An.n` identifies the analog-to-digital converter software version.
   `Dn.n` identifies the display software version.
   `Ln.n` identifies the programmable gate-array configuration version.

5. Other commands can be entered from the PC to gain familiarity with the instrument command set. All commands are summarized in Table 4-4 and explained in Table 4-5.

   For example: to reset the instrument, configure channel 0 to measure volts dc using the 300V DC scale (scale 4), send scan results to the RS-232 port, and scan once, enter the following:

   ```
   *RST  [Resets the instrument (which does not affect the communication parameters)]
   =>
   FUNC 0, VDC, 4  [Set channel 0 to volts dc and scale 4 (300V DC)]
   =>
   PRINT_TYPE 0,0  [Sets the data destination as the RS-232 port, and all data]
   =>
   PRINT 1  [Enables data logging to the RS-232 port]
   =>
   *TRG  [Triggers a single scan]
   =>
   ```

   ```
   15:17:04   07/21/94
    0:  000.00 VDC
   ALM:15  DIO:255  TOTAL:0
   ```

   To decode the printout, see Figure 5-3.

   The commands in the above example can be combined into a single entry by using the semicolon separator character:

   `*RST;FUNC 0,VDC,4;PRINT_TYPE 0,0;PRINT 1;*TRG.`

6. One of the following three possible prompts are returned when a command is sent to the instrument:

   `=>` The command was executed [Example, `PRINT 1`].

   `!>` The command was recognized, but not executed [Example, `PRINT 3`, where only `PRINT 0` and `PRINT 1` are legal entries].

   `?>` The command wasn't recognized [Example, `PRITN 1`, spelling error].

7. Exit the communications program and return to DOS, as required.

## Testing the RS-232 Interface Using GWBASIC 4-8.

Complete the procedure below to test the RS-232 link between the PC and instrument using GWBASIC interpreter commands. Identify the PC COM port used for the RS-232 link (COM1 is assumed).

1. Configure the Data Bucket communication parameters, as described in Figure 4-2, for bAUd = 9600, PAR = no, CtS = OFF, and Echo = On.
2. Turn on the PC and enter `GWBASIC` to start the BASIC interpreter.
3. With the entry screen displayed, enter the following commands (which are executed immediately). The last command returns an identification string and execution prompt:

```
OPEN "COM1,9600,N,8,1,CS,CD" FOR RANDOM AS #1
OK
PRINT #1, "*IDN?"
OK
PRINT INPUT$(46, #1)

*IDN?

FLUKE,2635A,0,Mn.n An.n Dn.n Ln.n

=>
```

`Mn.n` identifies the main software version.
`An.n` identifies the analog-to-digital converter software version.
`Dn.n` identifies the display software version.
`Ln.n` identifies the programmable gate-array configuration version.

If the identification string was not returned, be sure the instrument RS-232 port is configured for Echo = On (Figure 4-2). Verify that the commands were exact. For example, entering `PRINT #1, "*IDN"` instead of `PRINT #1, "*IDN?"` will hang up the program. Press <CNTL><BREAK> to escape, then re-enter the commands. If the wrong characters appear, there is an incompatibility in the COM port configurations (baud rate, parity, etc.). If everything seems normal, but characters still don't appear, check the RS-232 connection cable (see Appendix E).

One of the following three possible prompts are returned when a command is sent to the instrument:

| | |
|---|---|
| => | The command was executed [Example, `PRINT 1`]. |
| !> | The command was recognized, but not executed [Example, `PRINT 3`, where only `PRINT 0` and `PRINT 1` are legal entries]. |
| ?> | The command wasn't recognized [Example, `PRITN 1`, spelling error]. |

4. Other commands can be entered from the PC to gain familiarity with the instrument command set. All commands are summarized in Table 4-4 and explained in Table 4-5. For example: to reset the instrument, configure channel 0 to measure volts dc using the 300V DC scale (scale 4), send scan results to the RS-232 port, and scan once, enter the following [only the output of the last command is shown]:

```
PRINT #1, "*RST":PRINT INPUT$(10, #1)
PRINT #1, "FUNC 0, VDC,4":PRINT INPUT$(18, #1)
PRINT #1, "PRINT_TYPE 0,0":PRINT INPUT$(20, #1)
PRINT #1, "PRINT 1":PRINT INPUT$(13, #1)
PRINT #1, "*TRG":PRINT INPUT$(83, #1)
```

```
15:17:04  07/21/94
 0:  000.00 VDC
ALM:15  DIO:255  TOTAL:0
```

To decode the printout, see Figure 5-3.

The commands in the above example can be combined into a single entry by using the semicolon separator character:

```
PRINT #1, "*RST;FUNC 0,VDC,4;PRINT_TYPE 0,0;PRINT 1;
*TRG":PRINT INPUT$(124, #1)
```

If other commands are entered, remember that the input character count xxx for PRINT INPUT$(xxx, #1) command must be exact. A number too small will not read all the characters and will leave residual characters in the buffer, while a number too big will "hang up" the command until more characters are loaded into the buffer or <CNTL><BREAK>is pressed, which erases the buffer.

5. Enter SYSTEM to exit GWBASIC and return to DOS.

## Testing the RS-232 Interface Using QBASIC 4-9.

Complete the procedure below to test the RS-232 link between the PC and instrument using QBASIC compiler commands. Identify the PC COM port used for the RS-232 link (COM1 is assumed).

1. Configure the Data Bucket communication parameters, as described in Figure 4-2, for bAUd = 9600, PAR = no, CtS = OFF, and Echo = On.
2. Turn on the PC and enter QBASIC to start the BASIC compiler.
3. With the entry screen displayed, enter the following commands (which are not executed immediately):

```
OPEN "COM1,9600,N,8,1,CS,CD" FOR RANDOM AS #1
PRINT #1, "*IDN?"
PRINT INPUT$(46, #1)
```

4. Enter <SHIFT><F5> to run the program entered in step 3. If the RS-232 interface is operating correctly, the instrument returns an identification string and execution prompt similar to the following:

```
*IDN?

FLUKE,2635A,0,Mn.n An.n Dn.n Ln.n

=>
```

Mn.n identifies the main software version.
An.n identifies the analog-to-digital converter software version.
Dn.n identifies the display software version.
Ln.n identifies the programmable gate-array configuration version.

If the identification string was not returned, be sure the instrument RS-232 port is configured for Echo = On (Figure 4-2). Verify that the commands were exact. For example, entering PRINT #1, "*IDN" instead of PRINT #1, "*IDN?" will hang up the program. Press <CNTL><BREAK> to escape, then re-enter the commands. If the wrong characters appear, there is an incompatibility in the COM port configurations (baud rate, parity, etc.). If everything seems normal, but characters still don't appear, check the RS-232 connection cable (see Appendix E).

One of the following three possible prompts are returned when a command is sent to the instrument:

| | |
|---|---|
| `=>` | The command was executed [Example, `PRINT 1`]. |
| `!>` | The command was recognized, but not executed [Example, `PRINT 3`, where only `PRINT 0` and `PRINT 1` are legal entries]. |
| `?>` | The command wasn't recognized [Example, `PRITN 1`, spelling error]. |

5. Other commands can be entered from the PC to gain familiarity with the instrument command set. All commands are summarized in Table 4-4 and explained in Table 4-5. For example: to reset the instrument, configure channel 0 to measure volts dc using the 300V DC scale (scale 4), send scan results to the RS-232 port, and scan once, enter the following, then enter `<SHIFT><F5>` to run [only the output of the last command is shown]:

```
PRINT #1, "*RST":PRINT INPUT$(10, #1)
PRINT #1, "FUNC 0, VDC,4":PRINT INPUT$(18, #1)
PRINT #1, "PRINT_TYPE 0,0":PRINT INPUT$(20, #1)
PRINT #1, "PRINT 1":PRINT INPUT$(13, #1)
PRINT #1, "*TRG":PRINT INPUT$(83, #1)
```

```
15:17:04  07/21/94
 0:  000.00 VDC
ALM:15  DIO:255  TOTAL:0
```

To decode the printout, see Figure 5-3.

The commands in the above example can be combined into a single entry by using the semicolon separator character:

```
PRINT #1, "*RST;FUNC 0,VDC,4;PRINT_TYPE 0,0;PRINT 1;
*TRG":PRINT INPUT$(124, #1)
```

If other commands are entered, remember that the input character count `xxx` for `PRINT INPUT$(xxx, #1)` command must be exact. A number too small will not read all the characters and will leave residual characters in the buffer, while a number too big will "hang up" the command until more characters are loaded into the buffer or <CNTL><BREAK>is pressed, which erases the buffer.

6. Use Exit to exit QBASIC and return to DOS.

## COMPUTER INTERFACE COMMANDS AND OPERATION 4-10.

Operation of the computer interface between the instrument and PC normally involves the application software Starter (supplied) and Logger (optional), described in separate manuals. This section is provided for the user who wishes to develop his own software interface using the instrument command set. The topics in this section include:

- How the Instrument Processes Input
- Input Terminators
- Input String Examples
- Sending Numeric Values to the instrument
- How the Instrument Processes Output
- Status Registers
- Computer Interface Command Set

### How The Instrument Processes Input 4-11.

The instrument processes and executes valid input character strings from the host personal computer (PC). A valid input string is one or more syntactically correct commands, separated by semicolons (;) followed by an input terminator. The instrument stores received inputs in a 350-byte buffer. When an input string is received, it is not executed or checked for proper syntax until the input terminator is received. If the 350-byte input buffer becomes full, a device-dependent error prompt is returned, and further inputs to the string are ignored, except for a termination character. The instrument accepts alphabetic characters in either upper- or lower-case. If a command cannot be understood, the command and the rest of the command line are ignored.

Commands must be entered in the correct order as follows:

1. Commands to configure the instrument.
2. Commands that trigger a measurement.
3. Commands to read the results of a triggered measurement.
4. Commands to reconfigure the instrument (if any).

### Input Terminators 4-12.

An input terminator is a character sent by the host that identifies the end of a string. When the input terminator is received, the instrument executes all commands entered since the last terminator was received, on a first-in, first-out basis. If a communications error (e.g., parity, framing, overrun) is detected, a device-dependent error is generated. Valid terminators are LF (line feed), CR (carriage return), CR LF, and LF CR. In some instances, a terminator is automatically transmitted by the host at the end of the command string, for example, commands entered in BASIC.

### Input String Examples 4-13.

Below are four input string examples.
Example 1 - Select function for channel 1 as ohms, 30-k range, 2-wire connection.

```
FUNC 1, OHMS, 3, 2 <CR/LF>
```

Example 2 - Select function for channel 12 as temperature, using K-type thermocouple.

```
FUNC 12, TEMP, K <CR/LF>
```

Example 3 - Select function for channel 7 as temperature, using platinum RTD, 2-wire connection -and- set a new R0 [0 as in zero] value on the same channel of 101.22.

```
FUNC 7, TEMP, PT, 2;  RTD_R0 7, 101.22 <CR/LF>
```

Example 4 - Set the interval between scans to 10 minutes -and- start scanning -and- return the most recent measurement values for all scanned channels.

```
INTVL 0, 10, 0;   SCAN 1;   LAST? <CR/LF>
```

## Sending Numeric Values to the Instrument 4-14.

Numeric values can be sent to the instrument as integers, real numbers, or real numbers with exponents, as shown in the following examples:

| | |
|---|---|
| `+12345` | Sends the signed integer `+12345` |
| `123.45` | Sends the real number `123.45` |
| `-1.2345E+2` | Sends the number $-1.2345 \times 10^2$ |

## How the Instrument Processes Output 4-15.

The instrument outputs alphanumeric character strings in response to a query command from the host. A query command always ends with "?" (see Tables 4-4 and 4-5). An instrument output string is terminated by a CR/LF (carriage return/line feed). When the host sends a string to the instrument, wait for the instrument to return a prompt before sending another command string. If a second command is sent before the prompt is returned, a device-dependent command error (!>) is generated and the second string is ignored. The prompts are in one of three forms:

| | |
|---|---|
| => | The command was executed. [Example, `PRINT 1`] |
| !> | The command was recognized but couldn't be executed. [Example, `PRINT 3`, which has no meaning] |
| ?> | The command was not recognized due to syntax error. [Example, `PRITN 1`, spelling error] |

Numeric outputs from the instrument are either integer values or scientific notation values. For example:

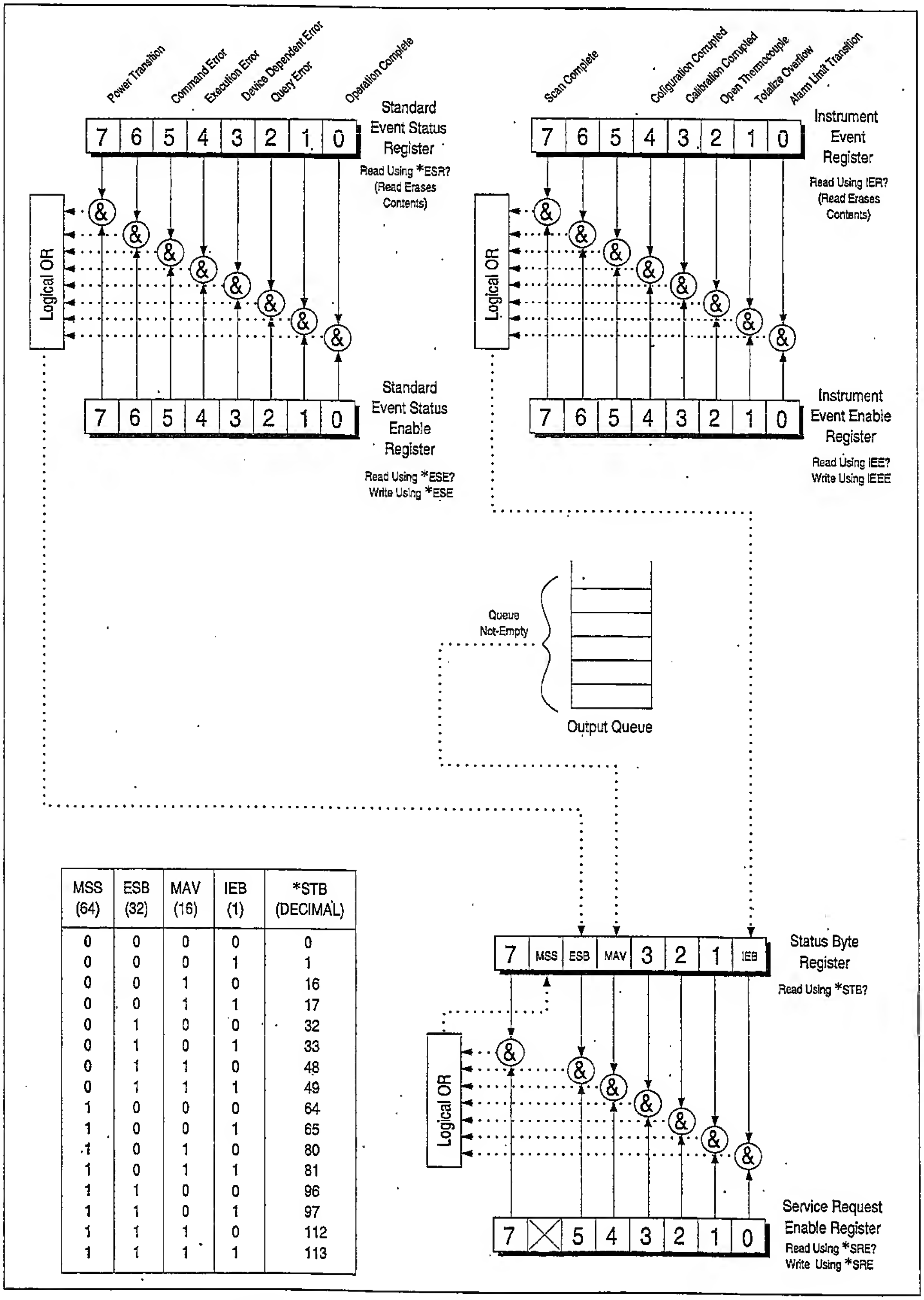
The query command `RANGE?` returns the number `3`.
The query command `ALARMS?` returns the number `0`.
A measurement returns `+1.2345E+6` ($1.2345 \times 10^6$).
Positive overload (OL on display) returns `+001.00E+9`
Negative overload (-OL on display) returns `-001.00E+9`
Open thermocouple (otc on display) returns `+009.00E+9`

## Status Registers 4-16.

Internal instrument operation is summarized in three data registers, which can be accessed to determine various events and status conditions before, during, and after instrument operation. Each register has a corresponding enable register to enable or mask (disable) any or all data register outputs. The relationship between the three registers is shown in Figure 4-3.

### INSTRUMENT EVENT REGISTER (IER)

The inputs to the Instrument Event Register (IER) include Scan Complete, Configuration Corrupted, Calibration Corrupted, Open Thermocouple, Totalize Overflow, and Alarm Limit Transition. Each input is described in Table 4-1. The output byte of the IER is ANDed with the output byte of the corresponding Instrument Event Enable Register (IEE). When there is logic high correlation between any of the bits of the IER and IEE registers, the associated Logical OR gate will output a logic high to the Instrument Event Bit (IEB) in the Status Byte Register.




| MSS (64) | ESB (32) | MAV (16) | IEB (1) | *STB (DECIMAL) |
|---|---|---|---|---|
| 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 1 | 1 |
| 0 | 0 | 1 | 0 | 16 |
| 0 | 0 | 1 | 1 | 17 |
| 0 | 1 | 0 | 0 | 32 |
| 0 | 1 | 0 | 1 | 33 |
| 0 | 1 | 1 | 0 | 48 |
| 0 | 1 | 1 | 1 | 49 |
| 1 | 0 | 0 | 0 | 64 |
| 1 | 0 | 0 | 1 | 65 |
| 1 | 0 | 1 | 0 | 80 |
| 1 | 0 | 1 | 1 | 81 |
| 1 | 1 | 0 | 0 | 96 |
| 1 | 1 | 0 | 1 | 97 |
| 1 | 1 | 1 | 0 | 112 |
| 1 | 1 | 1 | 1 | 113 |

**Figure 4-3. Overview of Status and Event Data Registers**

For example, an IER byte of binary 10000000 (decimal 128) indicates Scan Complete. If the IEE register is set to binary 10000000 (using the command `IEE 128`), then a Scan Complete condition will cause the Logical OR gate to output a logic high. In a similar manner, parameters can be combined. An IER byte of binary 10000101 (decimal 133) and an IEE set to a corresponding binary 10000101 (using the command `IEE 133`), will cause the Logical OR gate to have a logic high output for any of three conditions: Scan Complete -or- Open Thermocouple -or- Alarm Limit Transition.

Other commands include `IER?`, which returns the decimal equivalent of the IER byte and then clears the register to zero, and `IEE?`, which returns the decimal equivalent of the IEE byte. The command `*CLS` will clear all event registers. (See Appendix F for an 8-bit binary-coded-decimal table.)

**Table 4-1. Instrument Event Register (IER)**

| BIT | NAME | DESCRIPTION |
|---|---|---|
| 0 | ALT | Alarm Limit Transition. Set high (1) when any measurement value has transitioned into or out of alarm. Alarms are defined through the front panel or the computer interface (ALARM_LIMIT). This bit is cleared when read with IER? and when alarms or review values are cleared. |
| 1 | TOB | Totalize Overflow. Set high (1) when the Totalizer overflows (65,535). This bit is cleared when read with IER? and when the Totalizer is zeroed from the front panel or set to some other non-overflow value (<65,535) with the computer interface TOTAL command. |
| 2 | OTC | Open Thermocouple. Set high (1) when open thermocouple checking is enabled (with TEMP_CONFIG command) and any thermocouple channel is measured with a source impedance greater than 1 to 4 kilohms. |
| 3 | CCB | Calibration Corrupted. Set high (1) when the instrument calibration data is corrupted. When a calibration data check shows a corruption of calibration data, the calibration alarm bit remains set in the Instrument Status Register until the instrument is recalibrated. |
| 4 | CNC | Configuration Corrupted. The instrument configuration stored in NVRAM has been found to be corrupted. The RAM CRC is no longer valid. |
| 5, 6 | not used | Always set to 0. |
| 7 | SCB | Scan Complete. Set high (logic 1) when a measurement scan has been completed. This bit is cleared when read with IER? |

NOTES

Whenever the Instrument Event Register is read, the condition bits are cleared.

This register is used in conjunction with the Instrument Event Enable Register to determine the conditions under which the Instrument Event Bit of the Status Byte is set.

## STANDARD EVENT STATUS REGISTER (ESR)

The inputs to the Standard Event Status Register (ESR) include Power On, Command Error, Execution Error, Device Dependent Error, Query Error and Operation Complete. Each input is described in Table 4-2. The output byte of the ESR is ANDed with the output byte of the corresponding Standard Event Status Enable (ESE) register. When there is logic high correlation between any of the bits of the ESR and ESE registers, the associated Logical OR gate will output a logic high to the Event Status Bit (ESB) in the Status Byte Register.

For example, an ESR byte of binary 00010000 (decimal 16) indicates an Execution Error. If the ESE register is set to binary 00010000 (using the command `*ESE 16`), then an Execution Error condition will cause the Logical OR gate to output a logic high. In a similar manner, parameters can be combined. An ESR byte of binary 00110000 (decimal 48) and an ESE set to a corresponding binary 00110000 (using the command `*ESE 48`), will cause the Logical OR gate to have a logic high output for any of two conditions: Command Error or Execution Error.

Other commands include `*ESR?`, which returns the decimal equivalent of the ESR byte and then clears the register to zero, and `*ESE?`, which returns the decimal equivalent of the ESE byte. The command `*CLS` will clear all event registers. (See Appendix F for an 8-bit binary-coded decimal table.)

**Table 4-2. Event Status Register (ESR)**

| BIT | NAME | DESCRIPTION |
|---|---|---|
| 0 | OPC | Operation Complete. Set true (1) upon execution of the *OPC command, indicating that the instrument has completed all selected pending operations. |
| 1 | not used | Always set to 0. |
| 2 | QYE | Query Error. Sets the QYE bit of the ESR. Example would be *IDN?;*ESR? (vs. *ESR?;*IDN?). This causes the "?>" prompt to be returned. |
| 3 | DDE | Device Dependent Error. Generated true (1) by overflows of the RS-232 input buffer or by calibration errors. This causes the "!>" prompt to be returned. |
| 4 | EXE | Execution Error. Generated true (logic 1) by parameters out of bounds or by a valid command that could not be processed due to an internal condition (such as calibration commands being received when calibration is not enabled). This causes the "!>" prompt to be returned. |
| 5 | CME | Command Error. Generated true (1) by syntax errors, including: unrecognized command and incorrect command sequences. This causes the "?>" prompt to be returned. |
| 6 | not used | Always set to 0. |
| 7 | PON | Power Transition. Set true (logic 1) after an off-to-on transition has occurred in the instrument's power supply. |

## STATUS BYTE REGISTER (STB)

The inputs to the Status Byte Register (STB) include the Instrument Event Bit, Event Status Bit, and Message Available Bit. In addition, the STB register generates a Master Summary Status. Each input is described in Table 4-3. The output byte (except for bit 6) is ANDed with the output byte of the corresponding Service Request Enable Register (SRE). When there is a logic high correlation between any of the bits of the STB and SRE registers, the associated Logical OR gate will output a logic high that is used as a Master Summary Status (MSS) bit.

For example, an STB byte of binary 00100000 (decimal 32) indicates an Event Status Bit. If the SRE register is set to binary 00100000 (using the command `*SRE 32`), then an Event Status Bit will cause the Logical OR gate to output a logic high, which automatically sets bit 6 to high via the MSS input. Therefore, a query of the STB register (command `*STB?`) would return decimal 96 (binary 01100000).

Other commands include `*SRE?`, which returns the decimal equivalent of the SRE byte. The command `*CLS` will clear all event registers. (See Appendix F for an 8-bit binary-coded decimal table.)

**Table 4-3. Status Byte Register (STB)**

| BIT | NAME | DESCRIPTION |
|---|---|---|
| 0 | IEB | Instrument Event Bit. When any bit in the Instrument Event Register is set and the corresponding mask bit(s) in the Instrument Event Enable register is set, this Instrument Event Bit in the Status Byte will be set.<br><br>When read, the Instrument Event Bit is recomputed based on the new value from the Instrument Event Register and its mask, the Instrument Event Enable Register. |
| 1,2,3 | not used | Always set to 0. |
| 4 | MAV | Message Available (ASCII bytes available for output). |
| 5 | ESB | Event Status Bit |
| 6 | MSS | Master Summary Status |
| 7 | not used | Always set to 0. |

## Computer Interface Command Set 4-17.

Table 4-4 is a summary of computer interface commands and queries. A detailed description of each command or query, with examples, can be found in Table 4-5. Sample programs that use the command set are shown in Figure 4-4 (GWBASIC), Figure 4-5 (QBASIC) and Figure 4-6 (Quick C). Program examples are provided on the Starter application software floppy disk.

## XMODEM File Transfers 4-18.

The FILE_TX and FILE_RX computer commands are used to transfer memory card files in binary format over the RS-232 interface. The protocol implemented for file transfers is XMODEM, an 8-bit block-oriented protocol using CRC or checksums for error checking. When receiving a file, the protocol attempts to do CRCs but will fall back to checksums if CRCs are not sent. When FILE_TX and FILE_RX are used with terminal emulators, the emulator must support the XMODEM protocol; for example, the PC Windows terminal emulator. The PC software must support both 128-byte and 1024-byte data blocks. Since XMODEM is an 8-bit protocol, no parity must be selected when configuring the RS-232 ports and XON/XOFF flow control cannot be used.

When a FILE_TX or FILE_RX command is issued, it returns an immediate execution error prompt (!>) if the file transfer can not be initiated. If this prompt is not returned, then the XMODEM transfer may begin (refer to the communications software being used for the procedure to send or receive a binary file). When the file transfer is complete, the => prompt is returned. If an unrecoverable error occurred, the !> prompt is returned. As with any XMODEM transfer, the last block received, if it is not an even multiple of 128 or 1024 bytes, is padded with nulls. See the FILE_RX and FILE_TX commands in Table 4-5 for more information.

Table 4-4. Command and Query Summary

| | | |
|---|---|---|
| **Alarms** | | |
| | ALARMS? | Active Alarms Query |
| | ALARM_ASSOC | Associate Alarm Output |
| | ALARM_ASSOC? | Alarm Association Query |
| | ALARM_ASSOC_CLR | Alarm Association Clear |
| | ALARM_DO_LEVEL | Alarm Digital Output Level |
| | ALARM_DO_LEVELS? | Alarm Output State Query |
| | ALARM_LIMIT | Alarm Limit |
| | ALARM_LIMIT? | Alarm Limit Assignments Query |
| **Communications** | | |
| | ECHO | Turn the RS-232 Echo Mode on and off |
| **Digital I/O** | | |
| | DO_LEVEL | Set Digital Output Level |
| | DIO_LEVELS? | Digital I/O State Query |
| **Function and Range** | | |
| | FUNC | Channel Function Definition |
| | FUNC? | Channel Function Query |
| | RANGE? | Channel Range Query |
| | RTD_R0 | RTD Ice Point (R0) |
| | RTD_R0? | RTD Ice-Point (R0) Query |
| **Logging** | | |
| | LOG? | Retrieve Logged Data Query |
| | LOGGED? | Scan Data |
| | LOG_BIN? | Binary Upload of Logged Data |
| | LOG_CLR | Clear Logged Scans |
| | LOG_CLR_1 | Clear Oldest Logged Scan |
| | LOG_COUNT? | Logged Scan Count Query |
| | LOG_MODE | Action when Internal Memory is Full |
| | LOG_MODE? | Action when Internal Memory is Full Query |
| | PRINT | Data Logging Enable/Disable |
| | PRINT? | Data Logging Query |
| | PRINT_TYPE | Set Data Logging Type |
| | PRINT_TYPE? | Data Logging Type Query |
| **Measurement Rate** | | |
| | RATE | Select Measurement Rate |
| | RATE? | Measurement Rate Query |
| **Measurement Values** | | |
| | LAST? | Channel's Last Scan Value |
| | MAX? | Channel's Maximum Value |
| | MIN? | Channel's Minimum Value |
| | NEXT? | Next Scan's Values |

## Table 4-4. Command and Query Summary (Continued)

| | | |
|---|---|---|
| **Memory Card** | | |
| | DIR | Memory Card Files Directory |
| | FILE_ERROR? | File Error Query |
| | FILE_LOAD | Configuration File Load |
| | FILE_OPEN | Data File Open |
| | FILE_OPEN? | Data File Open Query |
| | FILE_REMOVE | File Remove |
| | FILE_RX | File Receive |
| | FILE_SPACE? | File Space Query |
| | FILE_STORE | Configuration File Store |
| | FILE_TAG? | File Tag Query |
| | FILE_TX | File Transmit |
| | MCARD? | Memory Card Status Query |
| | MCARD_DIR? | Memory Card Directory Query |
| | MCARD_FORMAT | Memory Card Format |
| | MCARD_SIZE? | Memory Card Size Query |
| **Monitor** | | |
| | MON | Enable/Disable Monitoring |
| | MON_CHAN? | Monitor Channel Number |
| | MON_VAL? | Monitor Channel Value |
| **Mx+B Scaling** | | |
| | SCALE_MB | Set Mx+B Scaling Values |
| | SCALE_MB? | Mx+B Scaling Values Query |
| **Operation Complete** | | |
| | *OPC | Operation Complete |
| | *OPC? | Operation Complete Query |
| **Remote/Local** | | |
| | LOCK | Lock/unlock front panel control keys |
| | LOCK? | Returns instrument front panel lock status |
| | LOCS | Local without Lockout |
| | LWLS | Local with Lockout |
| | REMS | Remote without Lockout |
| | RWLS | Remote with Lockout |
| **Reset** | | |
| | *RST | Reset |
| **Response Format** | | |
| | FORMAT | Response Format |
| | FORMAT? | Response Format Query |
| **Review Array** | | |
| | REVIEW_CLR | Clear Review Values |

Table 4-4. Command and Query Summary (Continued)

| | | |
|---|---|---|
| **Status Registers** | | |
| | *CLS | Clear Status |
| | *ESE | Event Status Enable |
| | *ESE? | Event Status Enable Query |
| | *ESR? | Event Status Register Query |
| | IEE | Instrument Event Enable |
| | IEE? | Instrument Event Enable Query |
| | IER? | Instrument Event Register Query |
| | *SRE | Service Request Enable Register |
| | *SRE? | Service Request Enable Register Query |
| | *STB? | Read Status Byte Query |
| **Scan** | | |
| | INTVL | Set Scan Interval |
| | INTVL? | Scan Interval Query |
| | SCAN | Enable/Disable Scanning |
| | SCAN? | Scan Query |
| | SCAN_TIME? | Time of Scan |
| **Temperature Options** | | |
| | TEMP_CONFIG | Temperature Configuration |
| | TEMP_CONFIG? | Temperature Configuration Query |
| **Test/Identification** | | |
| | *IDN? | Identification Query |
| | *TST? | Selftest Query |
| **Time/Date** | | |
| | DATE | Set the Instrument Date |
| | TIME | Set the Instrument Time |
| | TIME_DATE? | Retrieve Time and Date |
| **Totalizer** | | |
| | TOTAL | Set Totalizer Count |
| | TOTAL? | Totalizer Value Query |
| | TOTAL_DBNC | Set Totalizer Debounce |
| | TOTAL_DBNC? | Totalizer Debounce Query |
| **Triggering** | | |
| | *TRG | Single-Scan Trigger |
| | TRIGGER | Select Trigger Type |
| | TRIGGER? | Trigger Type Query |
| **Wait** | | |
| | *WAI | Wait-to-continue |

## Table 4-5. Command and Query Reference

| | |
|---|---|
| <CNTL><C> | Abort Command<br><br>Stops execution of command. |
| *CLS | Clear Status<br><br>Clears all event registers (ESR, IER) summarized in the status byte. |
| *ESE | Event Status Enable<br><br>Sets the Event Status Enable Register (ESE) to the given value.<br><br>*ESE <value><br><br><value> = 0, 1, 2, ... 255<br><br>The ESE register is used to enable or disable (mask) the output bits of the Standard Event Status Register (ESR). The ANDed output of the ESE and ESR is the Event Status Bit (ESB), which is used as an input for the Status Byte Register. See the previous discussion on status registers for more information.<br><br>Example: *ESE 176 [Enables the ESR byte 10110000 (decimal 176), which means the ESB will be set logic high by a Power Transition -or- Command Error -or- Execution Error.] |
| *ESE? | Event Status Enable Query<br><br>Returns an integer representing the present value of the Event Status Enable Register, as selected with the *ESE command. See the previous discussion on status registers for more information.<br><br>Example: *ESE? returns 160 [the ESE register is set for 10100000 (decimal 160), which means the Event Status Bit (ESB) will be set logic high by a Power Transition -or- Command Error.] |
| *ESR? | Event Status Register Query<br><br>Returns the value of the Standard Event Status Register (ESR) as an integer, then clears the register to 0. See the previous discussion on status registers for more information.<br><br>Example: *ESR? returns 48 [The ESR register is set for 00110000 (decimal 48), which means a Command Error and Execution Error were detected since last queried.] |

## Table 4-5. Command and Query Reference (Continued)

***IDN?**

Identification Query

Returns the instrument identification code.

The identification code consists of four descriptive fields separated by commas. Note that commas are reserved as field separators and cannot be used within the fields.

| FIELD | DESCRIPTION |
|---|---|
| 1 | Manufacturer's name (FLUKE). |
| 2 | Instrument model number (2635A). |
| 3 | 0 |
| 4 | Firmware revision levels. |

This query must be the last query on the input line, otherwise a query error is generated. It is legal to follow this query with other commands.

Example: *IDN? returns FLUKE,2635A,0,M6.2 A4.7 D1.0 L1.6 [Fluke product 2635A is running the main software version M6.2, Analog-to-Digital Converter software version A4.7, display software version D1.0, and programmable gate-array version L1.6.]

---

***OPC**

Operation Complete

Causes the instrument to generate an Operation Complete when parsed.

---

***OPC?**

Operation Complete Query

Causes the instrument to place an ASCII 1 in the output queue when parsed.

---

***RST**

Reset

Performs a Configuration Reset. The RS-232 computer interface parameters are not changed, and the temperature unit (°C or °F) is not changed.

---

***SRE**

Service Request Enable

Sets the Service Request Enable Register (SRE) to the given value.

*SRE <value>

<value> = 0, 1, 2, ... 255

The SRE register is used to enable or disable (mask) the output bits of the Status Byte Register (STB). The ORed output of the SRE and STB is the Master Summary Status (MSS) bit, which is used to signal the selected status bits have been set. See the previous discussion on status registers for more information. Note that bit 6 cannot be configured, and bits 1, 2, 3, and 7 are not used.

Example: *SRE 49 [Enables the STB byte 00110001 (decimal 49), which means the MSS bit is set logic high by an IEB bit -or- MAV bit -or- ESB bit.]

## Table 4-5. Command and Query Reference (Continued)

| | |
|---|---|
| *SRE? | Service Request Enable Query<br><br>Returns the integer value of the Service Request Enable Register (SRE). See the discussion on status registers for more information.<br><br>Example: *SRE? returns 32 [The SRE register is set for 00100000 (decimal 32), which means the Master Summary Bit will be set logic high when the ESB bit is set logic high.] |
| *STB? | Read Status Byte Query<br><br>Returns the integer value of the Status Byte, with bit 6 as the master summary bit. See the previous discussion on status registers for more information.<br><br>Example: *STB? returns 97 [The STB register is set for 01100001 (decimal 97), which means the Master Summary Bit, Event Status Bit, and Instrument Event Bit are set logic high.] |
| *TRG | Single-Scan Trigger<br><br>Commands the instrument to perform a single scan. If a scan is already in progress, the command is ignored.<br><br>If logging to memory card is enabled (PRINT_TYPE 3 or 6) and the memory card is missing, full, write-protected, or unformatted, the scan will be performed but an Execution Error will be generated. |
| *TST? | Self Test Query<br><br>Causes an internal selftest to be run, returning the result as an integer (representing the binary encoded value). The selftest does not require any local operator interaction and returns the instrument to the power-up state. The binary coding is: |

| BIT | RETURN | ERROR |
|---|---|---|
| 0 | 1 | Boot ROM Checksum Error1 |
| 1 | 2 | Instrument ROM Checksum Error |
| 2 | 4 | Internal RAM Test Failed |
| 3 | 8 | Display Power-Up Test Failed |
| 4 | 16 | Display Not Responding |
| 5 | 32 | Instrument Configuration Corrupted |
| 6 | 64 | Instrument Calibration Data Corrupted |
| 7 | 128 | Instrument Not Calibrated |
| 8 | 256 | A-to-D Converter Not Responding |
| 9 | 512 | A-to-D Converter ROM Test Failed |
| 10 | 1024 | A-to-D Converter RAM Test Failed |
| 11 | 2048 | A-to-D Converter Selftest Failed |
| 12 | 4096 | Memory Card Interface Not Installed |

Example: *TST? returns 2048 [The A/D self test failed.]

**Table 4-5. Command and Query Reference (Continued)**

| | |
|---|---|
| *WAI | Wait-to-continue<br><br>Prevents the parser from executing any more commands or queries until the No-Pending-Operations flag is true. Used in conjunction with *OPC and *OPC?. |
| ALARMS? | Active Alarms Query<br><br>Returns alarm status for a single scanned channel, or alarm status for all scanned channels.<br><br>ALARMS? <channel><br><br><channel> = 0,1,2 ... 20 -or- leave blank<br><br>The values returned represents data from the most recent scan, whether scanning is active or not. The integers returned indicates the alarms condition as follows:<br><br>0 Neither limit is in alarm and/or alarm(s) are not defined<br>1 Limit 1 in alarm<br>2 Limit 2 in alarm<br>3 Limit 1 and Limit 2 in alarm<br><br>For a single scanned channel, use ALARMS? <channel>. Return data for a single scanned channel consists of a single integer, as defined above. An Execution Error results if a request is made for a channel defined as OFF, the channel specified is invalid, no scan measurements have been made or are being made, or values have been cleared by REVIEW_CLR or by changing any parameter on any channel.<br><br>For all scanned channels, use ALARMS?. Return data for all scanned channels is a string of integers, separated by commas. The first digit represents the alarm status of the lowest channel scanned, and the last digit represents the alarm status of the highest channel scanned.<br><br>Example: ALARMS? 5 returns 1 [Channel 5 is in Limit 1 alarm.]<br><br>Example: ALARMS? returns 0,2,3,0,1,1 [Six channels were scanned. The first has no alarm or alarms were not defined, the second has a Limit 2 alarm, the third has both Limit 1 and Limit 2 in alarm, the fourth has no alarm or alarms were not defined, the fifth and sixth have a Limit 1 alarm.] |

## Table 4-5. Command and Query Reference (Continued)

**ALARM_ASSOC**

Associate Alarm Output

Configures alarm output associations at the rear panel DIGITAL I/O connector for channels 4 to 20.

ALARM_ASSOC <channel>, <limit_num>, <DO_line>

<channel> = 4, 5, 6, ... 20

<limit_num> = 1 or 2

<DO_line> = 0, 1, 2, ... 7

This command is used to associate a channel alarm for channels 4 to 20 with a rear panel DIGITAL I/O line (I/O 0 to I/O 7). Alarm conditions are asserted with a logical low (nominal +0.7V DC); non-alarm conditions are indicated by a logical high (nominal +5.0V DC). The default settings for channels 4 to 20 are ORed to the I/O lines in groups, as shown below.

| I/O 4 | I/O 5 | I/O 6 | I/O 7 |
|---|---|---|---|
| Chan | Chan | Chan | Chan |
| 4 | 5 | 6 | 7 |
| 8 | 9 | 10 | 11 |
| 12 | 13 | 14 | 15 |
| 16 | 17 | 18 | 19 |
| 20 | | | |

For example, if channel 6 or 10 or 14 or 18 goes into alarm (either Limit 1 or Limit 2), I/O 6 is asserted. This command changes the default settings or any other settings, as desired. Any number of channel alarm limits can be assigned to the same I/O line. For example, all alarms on all channels 4 to 20 could assert a single I/O line. Alarm associations can be returned to the default settings with an *RST configuration reset command. DIGITAL I/O lines are asserted while scanning. When scanning stops, the I/O lines set logic low remain low unless values have been cleared by a new alarm association, REVIEW_CLR, or by changing any parameter on any channel. If this command is entered during scanning while logging to the memory card, an Execution Error is generated.

Example: ALARM_ASSOC 10,1,2 [For channel 10, alarm Limit 1, assert DIGITAL I/O line 2.]

### Table 4-5. Command and Query Reference (Continued)

**ALARM_ASSOC?**

Alarm Association Query

Returns alarm output associations at the rear panel DIGITAL I/O connector for channels 4 to 20.

ALARM_ASSOC? <channel>, <limit_num>

<channel> = 4, 5, 6, ... 20

<limit_num> = 1 or 2

This command returns an integer that represents the DIGITAL I/O line active at the rear panel DIGITAL I/O connector for the specified channel and alarm limit. If default settings are in effect, returns follow the table below.

| I/O 4 | I/O 5 | I/O 6 | I/O 7 |
|---|---|---|---|
| Chan | Chan | Chan | Chan |
| 4 | 5 | 6 | 7 |
| 8 | 9 | 10 | 11 |
| 12 | 13 | 14 | 15 |
| 16 | 17 | 18 | 19 |
| 20 | | | |

If there is no association between an alarm and DIGITAL I/O line, there is no return and an Execution Error is generated. If this command is entered during scanning, an Execution Error is generated.

Example: ALARM_ASSOC? 10,1 returns 2 [Channel 10, alarm Limit 1, will assert DIGITAL I/O line 2.]

**ALARM_ASSOC_CLR**

Alarm Association Clear

Clears an alarm output association at the rear panel DIGITAL I/O connector for channels 4 to 20.

ALARM_ASSOC_CLR <channel>, <limit_num>

<channel> = 4, 5, 6, ... 20

<limit_num> = 1 or 2

This command removes all association between a DIGITAL I/O line at the rear panel DIGITAL I/O connector for the specified channels 4 to 20 and alarm limit. After application of this command, the previously associated DIGITAL I/O line is set high and new alarm conditions on this channel's alarm limit will not assert the DIGITAL I/O line. If this command is entered during scanning while logging to the memory card, an Execution Error is generated.

Example: ALARM_ASSOC_CLR 10,1 [Channel 10, alarm Limit 1, remove all association with a DIGITAL I/O line.]

## Table 4-5. Command and Query Reference (Continued)

| | |
|---|---|
| ALARM_DO_LEVEL | Alarm Digital Output Level<br>Configures rear panel ALARM OUTPUTS lines for I/O functions.<br>ALARM_DO_LEVEL <DO line>, <DO_state><br><DO line> = 0, 1, 2, 3<br><DO_state> = 1 or 0<br>The rear panel ALARM OUTPUTS lines 0 to 3 are hard-wired to output alarm conditions for channels 0 to 3, respectively. If all or some of channels 0 to 3 are not configured for alarm outputs, the associated ALARM OUTPUTS line can be assigned to go logic high or low with this command. The line may be set to a logical low (nominal +0.7V DC), or set to a logical high (nominal +5.0V DC).<br>Example: ALARM_DO_LEVEL 3,0 [Set ALARM OUTPUTS line 3 to a logical 0.] |
| ALARM_DO_LEVELS? | Alarm Output State Query<br>Returns an integer between 0 and 15 that summarizes the logical state of the rear panel ALARM OUTPUTS lines 0 to 3. Since the lines can be used as alarm outputs or DIGITAL I/O functions, the query represents the actual conditions at time of query. There are 16 possibilities, as shown below (0 = Logic low): |

| Line 3 | Line 2 | Line 1 | Line 0 | Returned Integer |
|---|---|---|---|---|
| 0 | 0 | 0 | 0 | 0 - (all 4 alarms active) |
| 0 | 0 | 0 | 1 | 1 |
| 0 | 0 | 1 | 0 | 2 |
| 0 | 0 | 1 | 1 | 3 |
| 0 | 1 | 0 | 0 | 4 |
| 0 | 1 | 0 | 1 | 5 |
| 0 | 1 | 1 | 0 | 6 |
| 0 | 1 | 1 | 1 | 7 |
| 1 | 0 | 0 | 0 | 8 |
| 1 | 0 | 0 | 1 | 9 |
| 1 | 0 | 1 | 0 | 10 |
| 1 | 0 | 1 | 1 | 11 |
| 1 | 1 | 0 | 0 | 12 |
| 1 | 1 | 0 | 1 | 13 |
| 1 | 1 | 1 | 0 | 14 |
| 1 | 1 | 1 | 1 | 15 - (no alarms active) |

Example: ALARM_DO_LEVELS? returns 15 [All lines are logic high.]

**Table 4-5. Command and Query Reference (Continued)**

| | |
|---|---|
| ALARM_LIMIT | Alarm Limit<br><br>Set alarm limit 1 or alarm limit 2 for any channel 0 to 20.<br><br>ALARM_LIMIT <channel>, <limit_num>, <sense>, <value><br><channel> = 0, 1, 2, 3, ... 20<br><limit_num> = 1 or 2<br><sense> = HI, LO, or OFF<br><value> = Signed numeric quantity<br><br>Two alarm limits, Limit 1 and Limit 2, can be assigned to any channel 0 to 20 that is not in the OFF mode. An alarm limit can be used for high alarms, meaning a HI alarm is set if a measurement exceeds the high alarm level, or low alarms, meaning a LO alarm is set if a measurement falls below the low alarm level. If only one of the alarms is used, the other alarm is turned OFF. The alarm value can be any signed number between .00000001 and 9999999, however, the instrument rounds to five significant digits. The signed numeric entries can be entered in scientific notation or as real numbers. If no polarity sign is used, the value is assumed to be positive. Alarm limit settings automatically clear from a channel if the channel function is changed. If Mx+B scaling is applied, alarm settings are based on the scaling, i.e., the actual instrument display. If this command is entered during scanning while logging to the memory card, an Execution Error is generated. Setting an alarm limit clears its alarm status and sets any associated ALARM or DIGITAL I/O line high.<br><br>Example: ALARM_LIMIT 5,1,LO,-65.872 [For channel 5, configure alarm Limit 1 as a low alarm with a value of -65.872.] |
| ALARM_LIMIT? | Alarm Limit Assignments Query<br><br>Return alarm limit 1 or alarm limit 2 for any channel 0 to 20.<br><br>ALARM_LIMIT? <channel>, <limit_num><br><channel> = 0, 1, 2, 3, ... 20<br><limit_num> = 1 or 2<br><br>For a selected channel and alarm limit, the returns include the sense of the alarm limit (HI, LO, OFF) plus the value of the alarm setting in scientific notation with five digits of resolution.<br><br>Example: ALARM_LIMIT? 13,1 returns LO,-4.5500E+0 [Channel 13, alarm Limit 1 is configured as a low alarm with a value of -4.55.] |
| *CLS | Clear Status<br><br>(See front of table.) |

## Table 4-5. Command and Query Reference (Continued)

| | |
|---|---|
| DATE | Set the Instrument Date<br><br>Set instrument calendar values.<br><br>DATE <month>, <date>, <year><br><month> = 1, 2, 3 ... 12<br><date> = 1, 2, 3, ... 31<br><year> = 00, 01, 02, ... 99<br><br>Invalid values generate an Execution Error.<br><br>Example: DATE 7,21,94 [Set date for July 21, 1994.] |
| DIO_LEVELS? | DIGITAL I/O State Query<br><br>Returns an integer between 0 and 255 that summarizes the logical state of the rear panel DIGITAL I/O lines 0 to 7. A logical 0 (low) means the line is asserted. Since the lines can be used as alarm outputs or digital inputs or outputs, the return represents the actual conditions at time of query. There are 256 possibilities, as shown in Appendix F.<br><br>Example: DIO_LEVELS? returns 145 [DIGITAL I/O lines 1, 2, 3, 5 and 6 are asserted (logic low).] |
| DIR | Memory Card Files Directory<br><br>Print a formatted listing of files on the memory card. This includes number of files, bytes used, and bytes free. While the directory is printing, all other operations in the instrument are suspended. If hardware or software flow control stall this output, the instrument waits for the output to be unstalled.<br><br>Example; DIR returns:<br><br>`DAT00.HYD 826 07-21-1994 16:20`<br>`DAT01.HYD 1082 07-21-1994 16:50`<br>`SET00.HYD 730 07-21-1994 17:10`<br>`SET01 HYD 730 07-21-1994 18:30`<br>`4 FILE(S) 3368 BYTES`<br>`1030656 BYTES FREE` |

**Table 4-5. Command and Query Reference (Continued)**

| | |
|---|---|
| DO_LEVEL | Set Digital Output Level<br><br>Configures the eight rear panel DIGITAL I/O connector lines, I/O 0 to I/O 7.<br><br>DO_LEVEL <DO_line>, <DO_state><br><DO_line> = 0, 1, 2, ... 7<br><DO_state> = 1 or 0<br><br>The rear panel DIGITAL I/O connector has eight lines, 0 to 7. Each line can be assigned to an I/O function. With this command, the line may be set to a logical low (nominal +0.7V DC), or set to a logical high (nominal +5.0V DC). DIGITAL I/O lines are asserted while scanning. When scanning stops, the I/O lines set logic low remain low unless values have been cleared by a new DO_LEVEL command, REVIEW_CLR, or by changing any parameter on any channel. Since I/O lines are shared with the alarm outputs of channels 4 to 20, verify DO_LEVEL commands will not cause ambiguities. (See the ALARM_ASSOC_CLR command to disassociate an alarm with an I/O line.) If this command is entered during scanning while logging to the memory card, an Execution Error is generated.<br><br>Example: DO_LEVEL 4,0 [Set I/O line 4 to a logical 0 (low).] |
| ECHO | Turn the RS-232 Echo Mode on and off.<br><br>ECHO 0 Turn ECHO off<br>ECHO 1 Turn ECHO on<br><br>The echo on mode allows character strings sent from the host to the instrument, to return (echo) back to the host. When operating the instrument from a terminal (or computer in the terminal emulation mode), ECHO 1 is usually selected. If this command is entered during scanning while logging to the memory card, an Execution Error is generated. |
| *ESE | Event Status Enable<br><br>(See front of table.) |
| *ESE? | Event Status Enable Query<br><br>(See front of table.) |
| *ESR? | Event Status Register Query<br><br>(See front of table.) |

### Table 4-5. Command and Query Reference (Continued)

<table>
<tr><td>FILE_ERROR?</td><td>File Error Query<br><br>Returns an integer number representing the last memory card error that was encountered. Once set, this value is only cleared (set to zero) by performing this query.<br><br>The possible card error codes are:<br><br>0 — No error since last queried or power up.<br><br>1 — Card error. No card, invalid file system on card, no file system on card, format operation failed, file could not be removed, and all other I/O errors.<br><br>2 — Bad file name, or out of file names (all 100 file names of the type being operated on are in use).<br><br>3 — Card error during scanning, but no data has been lost. Usually occurs when card fills during scanning.<br><br>4 — Card error during scanning, and data is being lost. The oldest scan data in the queue is being lost as each new scan completes.</td></tr>
<tr><td>FILE_LOAD</td><td>Configuration File Load<br><br>Loads the instrument configuration from a memory card configuration or data file.<br><br>FILE_LOAD <file><br><br><file> = SET00.HYD, SET01.HYD, ... SET99.HYD<br><br>-or-<br><br><file> = DAT00.HYD, DAT01.HYD, ... DAT99.HYD<br><br>Execution error if the file does not exist, if the file is not an instrument configuration or data file, if the file name is not valid, the card is not installed, or the card is not formatted. An execution error is also generated if either scanning or monitor is active. The file name convention is not checked (a data file may be loaded to recover a configuration).<br><br>Example: FILE_LOAD SET68.HYD [Loads configuration file SET68.HYD as the new instrument configuration.]</td></tr>
</table>

Table 4-5. Command and Query Reference (Continued)

| | |
|---|---|
| FILE_OPEN | Data File Open<br><br>Opens a data file for measurement logging.<br><br>FILE_OPEN <file><br><br><file> = DAT00.HYD, DAT01.HYD, ... DAT99.HYD<br><br>All scans are appended to this file until a file close is performed. The special name '*' opens the next available file in sequence. If no higher numbered file can be found, the algorithm "wraps" to zero and keeps searching. If no more file names are available, an Execution Error is generated. If the given file already exists, the file name does not match the convention, or scanning is already active, an Execution Error is generated. Logging is turned on and the card destination activated if this command is successfully executed.<br><br>Example: FILE_OPEN DAT31.HYD [Open data file DAT31.HYD for data logging.] |
| FILE_OPEN? | Data File Open Query.<br><br>Returns the name of the data file to be used for logging, or an Execution Error if no file is open.<br><br>Example: FILE_OPEN? returns DAT05.HYD [The file DAT05.HYD is open for data logging.] |
| FILE_REMOVE | File Remove<br><br>Remove the given file from the memory card.<br><br>FILE_REMOVE <file><br><br><file> = DAT00.HYD, DAT01.HYD, ... DAT99.HYD<br><br>-or-<br><br><file> = SET00.HYD, SET01.HYD, ... SET99.HYD<br><br>Removing the currently open data file will cause any scan data stored in internal memory waiting to be written to the file to be lost.<br><br>An Execution Error is generated if the file does not exist, the card is write-protected, the file name is invalid, card is not installed or the card is not formatted. The file name convention is not checked.<br><br>Example: FILE_REMOVE DAT00.HYD [Remove the DAT00.HYD file.] |

## Table 4-5. Command and Query Reference (Continued)

| | |
|---|---|
| FILE_RX | File Receive<br><br>The normal serial protocol is suspended and a binary transfer (XMODEM) is started between the instrument memory card and the host computer. Received data is typically an instrument configuration file transmitted from the host computer and using the naming convention, SETxx.HYD. If the file already exists, it is overwritten.<br><br>FILE_RX <file><br><br><file> = SET00.HYD, SET01.HYD, ... SET99.HYD<br><br>An Execution Error is generated under any of the following conditions: the card is not installed; the card is not formatted; the file cannot be created; scan or monitor is active; the instrument is configured for even or odd parity (parity must be "none"); or the instrument is configured for Echo On (Echo must be "Off"). See the FILE_TX command for transmitting data files. The file name convention is not checked, so any file may be transferred to the memory card. |
| FILE_SPACE? | File Space<br><br>Returns the number of kilobytes available for files on the memory card.<br><br>Example: FILE_SPACE? returns 1003 [There are 1003 kilobytes free on the memory card.] |
| FILE_STORE | Configuration File Store<br><br>Saves present instrument configuration in the given file.<br><br>FILE_STORE <file><br><br><file> = SET00.HYD, SET01.HYD, ... SET99.HYD<br><br>Configuration file names must match the naming convention 'SETxx.HYD' where xx is a two-digit integer number. If the given file already exists, it is overwritten. If there is not enough room to store a new configuration file, if the card is write-protected, card is not installed, or card is not formatted, an Execution Error is generated.<br><br>Example: FILE_STORE SET21.HYD [Save the present instrument configuration in the file SET21.HYD.] |

**Table 4-5. Command and Query Reference (Continued)**

| | |
|---|---|
| FILE_TAG? | Configuration File Tag<br><br>Return the tag from the given configuration or data file (<file> specified), or the present configuration tag (no <file> specified).<br><br>FILE_TAG? <file><br><br><file> = DAT00.HYD, DAT01.HYD, ... DAT99.HYD<br>-or-<br><file> = SET00.HYD, SET01.HYD, ... SET99.HYD<br>-or- leave blank<br><br>Instrument-created configurations use the configuration file name SETxx.HYD for this tag. If no tag has ever been used since the last full reset, or the specified file does not exist, an Execution Error is generated.<br><br>Example: FILE_TAG? SET17.HYD returns TESTFILE [Present configuration tag in SET17.HYD is the string TESTFILE (set by the user).] |
| FILE_TX | File Transmit<br><br>The normal serial protocol is suspended and a binary transfer (XMODEM) is started between the instrument memory card and the host computer. The instrument will transmit a DATxx.HYD file or SETxx.HYD file to the host computer.<br><br>FILE_TX<file><br><br><file> = DAT00.HYD, DAT01.HYD, ... DAT99.HYD<br>-or-<br><file> = SET00.HYD, SET01.HYD, ... SET99.HYD<br><br>An Execution Error is generated under any of the following conditions: the card is not installed; the card is not formatted; the file does not exist; scan or monitor is active; the instrument is configured for even or odd parity (parity must be "none"); or the instrument is configured for Echo On (Echo must be "Off"). See the FILE_RX command for receiving instrument configuration files. The file name convention is not checked, so any file may be transferred to the memory card. |

## Table 4-5. Command and Query Reference (Continued)

**FORMAT**

Response Format

Set the output format type to include or exclude measurement units.

FORMAT 1 Measurements returned without units.

FORMAT 2 Measurements returned with units.

Commands that return measurement data (like LAST?, NEXT?, MIN?, MAX?) can be expressed as a number only (FORMAT 1) or as a number with a measurement unit (FORMAT 2). If this command is entered during scanning while logging to the memory card, an Execution Error is generated. The measurement units are:

| MEASUREMENT | UNITS STRING |
|---|---|
| Scaled | MX+B |
| Volts DC | VDC |
| Volts AC | VAC |
| Resistance | OHMS |
| Frequency | HZ |
| Temperature °C | C |
| Temperature °F | F |

With FORMAT 1 asserted, typical returns would be +890.22E+0, +230.96E-3, 072.4E+0,+003.2E+0; with FORMAT 2 asserted, the returns would be +890.22E+0 HZ,+230.96E-3 VAC,072.4E+0 F,+003.2E+0 Mx+B.

**FORMAT?**

Response Format Query

Returns the output format type.

1 Measurements returned without units.

2 Measurements returned with units.

Commands that return measurement data (like LAST?, NEXT?, MIN?, MAX?) can be expressed as a number only (FORMAT 1) or as a number with a measurement unit (FORMAT 2). The measurement units are:

| MEASUREMENT | UNITS STRING |
|---|---|
| Scaled | MX+B |
| Volts DC | VDC |
| Volts AC | VAC |
| Resistance | OHMS |
| Frequency | HZ |
| Temperature °C | C |
| Temperature °F | F |

Example: FORMAT? returns 2 [Measurement data will be returned with a units indicator, e.g., +230.96E-3 VAC.]

## Table 4-5. Command and Query Reference (Continued)

**FUNC**

Channel Function Definition

Define the measurement function and range for the indicated channel. Changing a channel configuration automatically erases values held in review, and resets all ALARM OUTPUTS and DIGITAL I/O lines to logical high. The FUNC command clears any alarm limits and scaling values for this channel; therefore, define a channel function before setting alarm limits and/or scaling values for that channel.

FUNC <channel>, <function>, <range>, <terminals>

<channel> = 0, 1, 2, ... 20

<function> = OFF, VDC, VAC, OHMS, FREQ, TEMP

<range> = 1, 2, 3, ... 6, AUTO [VDC, VAC, OHMS, FREQ]

<range> = J, K, E, T, N, R, S, B, C [TEMP with thermocouples]

<range> = PT [TEMP with RTDs]

<terminals> = 2 or 4

Ohms and temperature measurements that use a 4-terminal configuration are limited to channels 1 to 10. Select a channel function, OFF, VDC, VAC, OHMS, FREQ, or TEMP. For voltage, ohms or frequency, select a range 1 to 6, as specified in the table below (or AUTO for autoranging) For temperature, select a thermocouple type, or PT for RTDs.

| RANGE | VOLTAGE | OHMS | FREQUENCY |
|---|---|---|---|
| 1 | 300 mV | 300Ω | 900 Hz |
| 2 | 3 V | 3 kΩ | 9 kHz |
| 3 | 30 V | 30 kΩ | 90 kHz |
| 4 | 150/300 V* | 300 kΩ | 900 kHz |
| 5 | 90 mV** | 3 MΩ | 1 MHz |
| 6 | 900 mV** | 10 MΩ | |

* 300V only on channels 0, 1, and 11.
** Volts DC only.

The <terminals> selection is specified only when the function type is OHMS, or TEMP using an RTD. The 2-terminal selection is valid on any channel. The 4-terminal selection is valid only for channels 1 to 10 (n), which automatically clears a channel a decade higher (n+10).

Example: FUNC 9,TEMP,PT,2 [Set the function of channel 9 to temperature measurements using a Platinum RTD, and the 2-terminal connection.]

Example: FUNC 5,VDC,4 [Set the function of channel 5 to volts DC, and use the 150V scale.]

## Table 4-5. Command and Query Reference (Continued)

| | |
|---|---|
| FUNC? | Channel Function Query<br><br>Returns the complete function for the indicated channel.<br><br>FUNC? <channel><br><br><channel> = 0, 1, 2, ... 20<br><br>The returns are in comma-separated data fields using the following format:<br><br><function>,<range>,<terminals><br><br>The <function> return is OFF, VDC, VAC, OHMS, FREΩ, or TEMP. For voltage, ohms, or frequency the <range> return is a number 1 through 6 (see below) or AUTO for autoranging. The <range> return for temperature is a thermocouple type [J, K, E, T, N, R, S, B, C] or PT for RTD measurements. The <terminals> return is for OHMS and TEMP functions only and is either 2 for 2-terminal measurements or 4 for 4-terminal measurements. For a 4-terminal configuration, the lower channel (n) returns OHMS or TEMP in the first field, and the upper channel (n+10) returns OFF. |

| RANGE | VOLTAGE | OHMS | FREQUENCY |
|---|---|---|---|
| 1 | 300 mV | 300Ω | 900 Hz |
| 2 | 3 V | 3 kΩ | 9 kHz |
| 3 | 30 V | 30 kΩ | 90 kHz |
| 4 | 150/300 V* | 300 kΩ | 900 kHz |
| 5 | 90 mV** | 3 MΩ | 1 MHz |
| 6 | 900 mV** | 10 MΩ | |

* 300V only on channels 0, 1, and 11.
** Volts DC only.

Example: FUNC? 8 returns TEMP,PT,4 [The function of channel 8 is temperature, using a Platinum resistance-temperature-detector (RTD), and a 4-terminal measurement configuration.]

| | |
|---|---|
| *IDN? | Identification Query<br><br>(See front of table.) |
| IEE | Instrument Event Enable<br><br>Sets the Instrument Event Enable Register (IEE) to the given value.<br><br>IEE <value><br><br><value> = 0, 1, 2, ... 255<br><br>The IEE register is used to enable or disable (mask) the output bits of the Instrument Event Register (IER). The combined output of the IEE and IER is the Instrument Event Bit (IEB), which is used as an input for the Status Byte Register. See the discussion on status registers for more information.<br><br>Example: IEE 5 [Enables the IER output byte 00000101 (decimal 5), which means an Open Thermocouple -or- Alarm Limit Transition will set IEB logic high.] |

Table 4-5. Command and Query Reference (Continued)

| | |
|---|---|
| IEE? | Instrument Event Enable Query<br><br>Returns the present value of the Instrument Event Enable Register (IEE) as an integer, as selected with the IEE command. See the discussion on status registers for more information.<br><br>Example: IEE? returns 128 [The IEE register is set for 10000000 (decimal 128), which means a Scan Complete will set IEB logic high.] |
| IER? | Instrument Event Register Query<br><br>Returns the value of the Instrument Event Register (IER) as an integer, then clears the register to 0. See the discussion on status registers for more information.<br><br>Example: IER? returns 133 [The IER register is set for 10000101 (decimal 133), which means a Scan Complete, Open Thermocouple, and Alarm Limit Transition were detected.] |
| INTVL | Set Scan Interval<br><br>Set scan interval time.<br><br>INTVL <hours>, <minutes>, <seconds><br><br><hours> = 0, 1, 2, ... 9<br><minutes> = 0, 1, 2, ... 99<br><seconds> = 0, 1, 2, ... 99<br><br>An Execution Error is generated if values outside the specified ranges are used or if the instrument is scanning.<br><br>Example: INTVL 1,30,0 [Set the interval time to 1 hour, 30 minutes and 0 seconds.] |
| INTVL? | Scan Interval Query<br><br>Return scan interval time. Returns the scan interval time in the format <hours>,<minutes>,<seconds>.<br><br>Example INTVL? returns 0,0,0 [The interval time is 0 hours, 0 minutes, and 0 seconds (continuous scanning).] |

## Table 4-5. Command and Query Reference (Continued)

| | |
|---|---|
| LAST? | Channel's Last Scan Value<br><br>Returns the last measured value(s) for the scan in progress or the last completed scan.<br><br>LAST? <channel><br><br><channel> = 0, 1, 2, ... 20<br><br>Returns last measurement values for either the indicated channel, or for all defined channels if the <channel> field is left blank. An Execution Error results if a request is made for a channel defined as OFF, the channel specified is invalid, the channel specified has been set up but not yet measured, or Review array values have been cleared by REVIEW_CLR, or by changing any parameter on any channel.<br><br>The returned value is a signed number with decimal point and exponent. For slow scanning rate, 5 digits are returned (±XX.XXXE±N); for fast scanning rate, 4 digits are returned (±XX.XXE±N). The channel range setting determines placement of the decimal point. A return of +001.00E+9 indicates an overload (OL) condition; a return of +009.00E+9 indicates an open thermocouple (otc) condition. If no channel specification is made, all the last values of the scanned channels are returned, each separated by a comma.<br><br>Example: LAST? 1 returns +0074.4E+0 [The last scanned value of channel 1 is 74.4.]<br><br>Example: LAST? returns +060.14E+0,+013.84E+0,+009.00E+9 [Three channels were scanned. The first channel had a last reading of 60.14; the second channel had a last reading of 13.84; the third channel reading indicates an open thermocouple (RATE 0 and FORMAT 1 are asserted).] |

## Table 4-5. Command and Query Reference (Continued)

| | |
|---|---|
| LOCK | Lock and unlock the instrument front panel control keys.<br><br>The LOCK modes disable the front panel keys, while placing the instrument in either REVIEW (LOCK 1), MONITOR (LOCK 2) or Configuration Lock (LOCK 3). This limits instrument operation to a specific mode and prevents unauthorized configuration changes. Only supervisory personnel should be aware that the FUNC and Mx+B keys can be used to toggle the LOCK modes on and off, except for LOCK 3, which is reset from the computer interface only or by loading a non-LOCK 3 setup file.<br><br>LOCK modes 1 and 2 are not saved/restored in configuration files. If one of these modes is active when FILE_STORE is performed, mode 0 (unlocked) is stored in the file.<br><br>LOCK <mode><br><br><mode> = 0, 1, 2, 3<br><br>LOCK 0 — Unlock the front panel and turn off the REM (remote) annunciator. All key functions are enabled. This command is used to clear a LOCK 1, LOCK 2, or LOCK 3 condition.<br><br>LOCK 1 — Lock the front panel in the REVIEW mode and turn on the REM (remote) annunciator. Only the up/down and left/right arrow keys are unlocked to allow the review of the minimum, maximum, and last values of any channel. The front panel can be unlocked by using the LOCK 0 command, or by simultaneously pressing the front panel FUNC and Mx+B keys. The FUNC and Mx+B keys can be used to toggle between the locked and unlocked modes, while in REVIEW.<br><br>LOCK 2 — Lock the front panel in the MONITOR mode (which must be active or the command will generate an execution error) and turn on the REM (remote) annunciator. Only the up/down arrow keys are unlocked to allow the monitoring of any channel. The front panel can be unlocked by using the LOCK 0 command, or by simultaneously pressing the front panel FUNC and Mx+B keys. The FUNC and Mx+B keys can be used to toggle between the locked and unlocked modes, while in MON.<br><br>LOCK 3 — Lock the channel configuration. The instrument operates normally except keys used to configure a channel are disabled, that is, the configuration is locked. A configuration file can be loaded; scan can be turned on/off, monitor on/off, and review on/off. Exit this mode using the power-up configuration-reset sequence from the instrument front panel or load a configuration file that has lock-out disabled.<br><br>The four LOCK states are nonvolatile. If power is interrupted, the instrument retains the last LOCK setting. |

## Table 4-5. Command and Query Reference (Continued)

| | |
|---|---|
| LOCK? | Returns the instrument front panel lock status, as selected with the LOCK command.<br>0 Front panel keys are unlocked. All key functions are enabled.<br>1 Front panel keys are locked, except for up/down and left/right arrow keys, which are used to review the minimum, maximum and last values of any channel.<br>2 Front panel keys are locked, except for the up/down arrow keys, which are used to monitor any channel.<br>3 Front panel keys can be used, except those used to configure a channel. |
| LOCS | Local without Lockout<br>All front panel keys are enabled, and the REM annunciator is not lit. This is the state assumed by the instrument at power-up reset. To disable all the front panel keys, use the LWLS command. |
| LOG? | Retrieve Logged Data Query<br>Return the oldest logged scan values for all configured channels and remove them from internal memory (maximum 100 scans). This query is valid during scanning. The remaining count of stored scans (LOG_COUNT? command) is decremented by 1. Channels defined as OFF are not included. If there are no logged scans to remove, an Execution Error is generated.<br>The returns includes the following information:<br>• Date and time at the start of the logged scan.<br>• Values for the channels measured.<br>• Status of ALARM OUTPUTS, DIGITAL I/O, and totalize count.<br>Logging scans in internal memory is enabled by the PRINT and PRINT_TYPE commands.<br>Example: LOG? returns 16,15,30,7,21,94,+034.53E-3 VAC,+09.433E+0 VDC,+1.2043E+6 OHMS,15,255,+00.000E+3 [The oldest recorded scan, that started at 1600 hours, 15 minutes, 30 seconds, on July 21, 1994, measured three channels with readings 34.53mVAC, 9.433 VDC, 1.2043 M OHMS, with ALARM OUTPUTS status 15, DIGITAL I/O status 255, and totalize count of 0 (RATE 0 and FORMAT 2 are asserted).] |

Table 4-5. Command and Query Reference (Continued)

| | |
|---|---|
| LOGGED? | Scan Data<br><br>Returns specified scan data from internal memory<br><br>LOGGED? <index><br><br><index> = 1, 2, 3, ..., 100<br><br>A maximum of 100 scans can be recorded in the internal memory. This command is used to retrieve a particular scan. If the <index> number has no associated scan, an Execution Error is returned.<br><br>Logging scans in internal memory is enabled by the PRINT and PRINT_TYPE commands.<br><br>Scan data is returned in the same format as for the LOG? query. |
| LOG_BIN? | Binary Upload of Logged Data.<br><br>Returns a single ASCII string, which encodes the raw binary data stored at the specified <index> position.<br><br>LOG_BIN? <index><br><br><index> = 1, 2, 3, ... 100<br><br>See Appendix D for a discussion of the LOG_BIN? command. |
| LOG_CLR | Clear Logged Scans<br><br>Clear all stored scan data from the internal memory (maximum 100 scans). |
| LOG_CLR_1 | Clear Oldest Logged Scan<br><br>Clears the oldest (first) scan in the internal memory. If there are no scans in internal memory, an Execution Error is generated. A total of 100 scans can be saved in the log queue. |
| LOG_COUNT? | Logged Scan Count Query<br><br>Return the number of stored scans. Returns an integer value representing the number of scans presently stored in internal memory (maximum 100). A return of 0 indicates that there are no stored scans.<br><br>Logging scans in internal memory is enabled by the PRINT and PRINT_TYPE commands.<br><br>Example: LOG_COUNT? returns 33 [The internal memory holds data from the last 33 scans.] |
| LOG_MODE | Action when Internal Memory is Full.<br><br>Determines what action is taken when 100 scans have been recorded<br><br>LOG_MODE 0 Discard the oldest scans and record new scans.<br><br>LOG_MODE 1 Maintain the oldest scans and discard new scans.<br><br>The LOG_MODE setting is nonvolatile and cannot be changed from the instrument front panel. The default is LOG_MODE 0. |

## Table 4-5. Command and Query Reference (Continued)

| | |
|---|---|
| LOG_MODE? | Action when Internal Memory is Full Query<br><br>Returns 0 or 1 to indicate what action will be taken when 100 scans have been recorded<br><br>0 Discarding the oldest scans to record new scans.<br><br>1 Maintaining the oldest scans and discarding new scans. |
| LWLS | Local with Lockout<br><br>All front panel keys are disabled. The REM annunciator is not lit. This command can be used when the instrument is scanning or monitoring. To clear, use the LOCS command. |
| MAX? | Channel's Maximum Value<br><br>Returns the maximum value(s) measured since the review array was last cleared.<br><br>MAX? <channel><br><br><channel> = 0, 1, 2, ... 20, or leave blank<br><br>Returns maximum measurement values for either the indicated channel, or for all defined channels if the <channel> field is left blank. An Execution Error results if a request is made for a channel defined as OFF, the channel specified is invalid, the channel specified has been set up but not yet measured, or Review array values have been cleared by REVIEW_CLR, or by changing any parameter on any channel.<br><br>The return is a signed number with decimal point and exponent. For slow scanning rate, 5 digits are returned (±XX.XXXE±N); for fast scanning rate, 4 digits are returned (±XX.XXE±N). The channel range setting determines placement of the decimal point. A return of +001.00E+9 indicates an overload (OL) condition; a return of +009.00E+9 indicates an open thermocouple (otc) condition. If no channel specification is made, all the maximum values of the scanned channels are returned, each separated by a comma.<br><br>Example: MAX? 1 returns +022.34E+0 [The maximum scanned value of channel 1 is 22.34.]<br><br>Example: MAX? returns +009.00E+9,+890.22E+0,+230.96E-3 [Three channels were scanned. The first channel shows an open thermocouple; the second channel had a maximum reading of 890.22; the third channel had a maximum reading of 0.230 (RATE 0 and FORMAT 1 are asserted).] |

## Table 4-5. Command and Query Reference (Continued)

**MCARD?**

Memory Card Status

Returns the memory card status as an encoded integer number from a binary number using bits 0 to 4.

Bit 0 - Card changed; remaining bits differ from the last query
Bit 1 - A card is present in the unit
Bit 2 - Card is write protected
Bit 3, 4 - Battery status of last inserted card, as below:

| BIT 4 | BIT 3 | MEMORY CARD BATTERY STATUS |
|---|---|---|
| 0 | 0 | Battery operational |
| 0 | 1 | Battery should be replaced; data is OK |
| 1 | 0 | Battery and data integrity not guaranteed |
| 1 | 1 | Battery and data integrity not guaranteed |

Example: MCARD? returns 7 [The memory card status is 00111 (decimal 7), meaning the card changed since the last query, a card is in the unit, the card is write protected, and battery is operational.]

**MCARD_DIR?**

Memory Card Directory

Returns a terminated string for each file in the root directory of the memory card. The string is a comma-separated list of the file's name, size, modification date (day, month, year) and time (hours, minutes, seconds).

Example: MCARD_DIR? returns:

```
DAT00.HYD,826,7,21,1994,16,20,44
DAT01.HYD,810,7,21,1994,16,50,10
SET00.HYD,730,7,21,1994,17,10,32
SET01.HYD,730,7,21,1994,18,30,03
```

**MCARD_FORMAT**

Format Memory Card

Memory card inserted in the Data Bucket will be formatted. The card must be the static RAM (SRAM) type, meeting PCMCIA standards. An Execution Error is generated and the card not formatted if scanning is in progress, the card is of unknown size, or card is write-protected. If the memory card contains a PCMCIA card information structure (CIS), the card size is determined from the CIS. Otherwise, the size is algorithmically determined by writing to the memory card. A CIS is never written to the card.

When formatting a memory card, any scan data that has been stored in internal memory waiting to be written to a valid memory card will be lost.

**MCARD_SIZE?**

Memory Card Size

Returns the memory card size as an integer number of kilobytes.

Example: MCARD_SIZE? returns 1024 [Memory card size is 1024 kilobytes (1 megabyte).]

### Table 4-5. Command and Query Reference (Continued)

| | |
|---|---|
| MIN? | Channel's Minimum Value<br><br>Returns the minimum value(s) measured since the review array was last cleared.<br><br>MIN? <channel><br><br><channel> = 0, 1, 2, ... 20, or leave blank<br><br>Returns minimum measurement values for either the indicated channel, or for all defined channels if the <channel> field is left blank. An Execution Error results if a request is made for a channel defined as OFF, the channel specified is invalid, the channel specified has been set up but not yet measured, or Review array values have been cleared by REVIEW_CLR, or by changing any parameter on any channel.<br><br>The return is a signed number with decimal point and exponent. For slow scanning rate, 5 digits are returned (±XX.XXXE±N); for fast scanning rate, 4 digits are returned (±XX.XXE±N). The channel range setting determines placement of the decimal point. A return of +001.00E+9 indicates an overload (OL) condition; a return of +009.00E+9 indicates an open thermocouple (otc) condition. If no channel specification is made, all the minimum values of the scanned channels are returned, each separated by a comma.<br><br>Example: MIN? 16 returns +167.85E+3 [The minimum scanned value of channel 16 is 167,850 (RATE 0 and FORMAT 1 are asserted).]<br><br>Example: MIN? returns +091.67E+0,+001.00E+9,+115.21E-3 [Three channels were scanned. The first channel had a minimum reading of 91.67; the second channel is in overload (OL); the third channel had a minimum reading of 0.11521 (RATE 0 and FORMAT 1 are asserted).] |

**Table 4-5. Command and Query Reference (Continued)**

| | |
|---|---|
| MON | Enable/Disable Monitoring<br><br>This command performs the same function as the MON key on the front panel.<br><br>MON 1, <channel><br><channel> = 0, 1, 2 ... 20<br>MON 0 Disables monitoring<br><br>MON 1 commands enable monitoring for the specified channel, or if already monitoring, changes to the specified channel. MON 0 disables monitoring.<br><br>The <channel> parameter can be 0 through 20. A command error is generated if no <channel> parameter is given when enabling monitoring. If the channel to be monitored is invalid or defined as OFF, or if values other than 0 or 1 are given, an Execution Error is generated.<br><br>The MON and SCAN commands work in conjunction with the front panel controls. The Monitor and Scan functions can be enabled or disabled from either the front panel or the computer interface. The most recently specified monitor channel (from front panel or computer interface) becomes the one channel monitored.<br><br>Example: MON 1,6 [Turn on monitor and monitor channel 6.]<br><br>Example: MON 0 [Turn monitor off.] |
| MON_CHAN? | Monitor Channel Number<br><br>This query asks for the number of the presently defined monitor channel. If monitoring is not active, an Execution Error is generated.<br><br>Example: MON_CHAN? returns 9 [Channel 9 is being monitored.]<br><br>Example: MON_CHAN? returns nothing and generates an Execution Error [No channel is being monitored.] |
| MON_VAL? | Monitor Channel Value<br><br>This query asks for a measurement on the monitor channel. If monitoring is not active, an Execution Error results. A return of +001.00E+9 indicates an overload (OL) condition; a return of +009.00E+9 indicates an open thermocouple (otc) condition.<br><br>Example: MON_VAL? returns +115.67E+0 VAC [The channel being monitored was measured to have a value of 115.67 VAC (RATE 0 and FORMAT 2 are asserted).]<br><br>Example: MON_VAL? returns nothing and generates an Execution Error [No channel is being monitored.] |

## Table 4-5. Command and Query Reference (Continued)

| | |
|---|---|
| NEXT? | Next Scan's Values<br><br>The NEXT? query returns data values for the next complete scan. If a scan is in progress when the NEXT? query is processed, the data values returned are from that scan. If a scan is not presently in progress, the NEXT? query waits for data to become available. While waiting, no other commands can be issued. To exit NEXT? while waiting, use <CNTL> <C>.<br><br>NEXT? returns comma-separated information for the date and time at the start of the next measurement scan, the values for channels measured, followed by the state of the DIGITAL I/O lines, and the totalizer count.<br><br>The time and date are returned in the following order: Hours (0-23), Minutes (0-59), Seconds (0-59), Month (1-12), Date (1-31), Year (0-99). Measurement data is returned as a list of scientific notation values. For an overload (OL), "+001.00E+9" is returned. If an open thermocouple is detected, "+009.00E+9" is returned. ALARM OUTPUTS and DIGITAL I/O values are returned as integer values. (To decode the ALARM OUTPUTS integer, see the ALARM_DO_LEVELS? command; to decode the DIGITAL I/O integer, see the DIO_LEVELS? command.) The totalizer value is returned as a scientific notation value.<br><br>Example: NEXT? returns 16,11,47,7,21,94,+1.0099E+3, +04.556E+0,-13.665E+0,+1.2664E+6,+009.00E+9,15,255, +00.455E+3 [At 1600 hours, 11 minutes, 47 seconds, on July 21, 1994, five channels were scanned with the measurements 1009.9, 4.556, -13.665, 1,266,400, open thermocouple, Alarms I/O status was 15, DIGITAL I/O status was 255, and totalizer count was 455 (RATE 0 and FORMAT 1 are asserted).]<br><br>Example: NEXT? returns nothing and the computer interface does not accept commands [The NEXT? command was entered when the instrument was not scanning. Press the front panel SCAN key, or enter <CNTL><C> to clear the NEXT? command.] |
| *OPC | Operation Complete<br><br>(See front of table.) |
| *OPC? | Operation Complete Query<br><br>(See front of table.) |

Table 4-5. Command and Query Reference (Continued)

| | |
|---|---|
| PRINT | Data Logging Enable/Disable<br><br>The destination and conditions for data logging are determined by the PRINT_TYPE command, while this command enables or disables the logging of the measurement data.<br><br>PRINT 0 Disable data logging to memory card and printer<br><br>PRINT 1 Enable data logging to memory card and printer<br><br>The PRINT command does not affect the logging of data (100 scans maximum) to the internal memory (log queue), which is always active when selected as a destination (PRINT_TYPE 1,2,5, or 6). If scanning is already active, an Execution Error is generated.<br><br>When PRINT 1 is asserted, the instrument front panel PRN (Logging) annunciator is on. When PRINT 0 is asserted, the instrument front panel PRN annunciator is off. |
| PRINT? | Data Logging Query<br><br>Returns the status of data logging, as selected with the PRINT command.<br><br>0 PRINT 0 is selected (data logging disabled)<br><br>1 PRINT 1 is selected (data logging enabled) |

## Table 4-5. Command and Query Reference (Continued)

**PRINT_TYPE**

Set Data Logging Type

Set the destination and condition for data logging. When data logging is enabled with the PRINT command, the destination and conditions are set with the PRINT_TYPE command. The <<destination>> is selected with an integer (0 to 6), and the <<type>> is selected with an integer (0 to 2). Internal memory is limited to 100 scans. To extract the data from the internal memory, see the LOG? and LOGGED? commands. Attempting to use this command to select a memory card as the logging destination while scanning will cause an Execution Error.

PRINT_TYPE <destination>, <type>

<destination> = 0, 1, 2, ... 6

0 = Log data to printer
1 = Log data to log queue
2 = Log data to log queue and printer
3 = Log data to memory card
4 = Log data to memory card and printer
5 = Log data to memory card and log queue
6 = Log data to memory card, log queue, and printer

<type> = 0, 1 or 2

0 = Record all scans
1 = Record scans if any scanned channel is in alarm
2 = Record scans when any alarm transitions

When the log queue is selected as the destination, all scans are automatically recorded in the log queue as if type 0 was selected. Types 1 and 2 are ignored for the log queue, but are still executed for other destinations selected (i.e., the printer and memory card).

The PRINT command does not affect the logging of data (100 scans maximum) to the internal memory (log queue), which is always active when selected as a destination (PRINT_TYPE 1, 2, 5 or 6).

Example: PRINT_TYPE 3,1 [When data logging is enabled (see PRINT command), send data to the memory card but only if one of the scanned channels is in alarm.]

## Table 4-5. Command and Query Reference (Continued)

| | |
|---|---|
| PRINT_TYPE? | Data Logging Type Query<br><br>Returns the status of data logging destination and condition, as selected with the PRINT_TYPE command. Returns two integers in the form <destination>,<type> as follows:<br><br><destination> = 0, 1, 2, ... 6<br><br>0 = Log data to printer<br>1 = Log data to internal memory<br>2 = Log data to internal memory and printer<br>3 = Log data to memory card<br>4 = Log data to memory card and printer<br>5 = Log data to memory card and internal memory<br>6 = Log data to memory card, internal memory, and printer<br><br><type> = 0, 1 or 2<br><br>0 = Record all scans<br>1 = Record scans if any scanned channel is in alarm<br>2 = Record scans when any alarm transitions<br><br>Example: PRINT_TYPE? returns 5,0 [Destination for logged data is to the memory card and internal memory, and all scans are recorded.] |

## Table 4-5. Command and Query Reference (Continued)

| | |
|---|---|
| RANGE? | Channel Range Query |

Returns the range(s) used for the scan in progress or the last completed scan. If a channel is configured for autoranging, the actual range used for the measurement is returned.

RANGE? <channel>

<channel> = 0, 1, 2, ... 20, or leave blank

If the <channel> specification field is left blank, values for all defined channels are returned. An Execution Error results if a request is made for a channel defined as OFF, the channel specified is invalid, or if the channel has been set up but not measured with at least one scan. The range value returned is not affected by Mx+B scaling.

An integer value (1-6) is returned, based on the table below. Temperature functions (thermocouple and RTD) always return a 1. Commas separate the integers if the return is for all scanned channels.

| RANGE | VOLTAGE | OHMS | FREQUENCY |
|---|---|---|---|
| 1 | 300 mV | 300Ω | 900 Hz |
| 2 | 3 V | 3 kΩ | 9 kHz |
| 3 | 30 V | 30 kΩ | 90 kHz |
| 4 | 150/300 V* | 300 kΩ | 900 kHz |
| 5 | 90 mV** | 3 MΩ | 1 MHz |
| 6 | 900 mV** | 10 MΩ | |

* 300V only on channels 0 and 11.
** Volts DC only.

Example: RANGE? 12 returns 3 [Channel 12 has a range of 3. If measuring voltage, it would indicate the 30V scale.]

Example: RANGE? returns 2,2,1,6 [Four channels were scanned. The first and second have a range of 2, the third a range of 1, and the fourth a range of 6.]

| | |
|---|---|
| RATE | Select Measurement Rate |

Specifies the measurement rate. Changing the measurement rate also clears the Review array, and ALARM OUTPUTS and DIGITAL I/O lines.

RATE 0 Selects the slow measurement rate.

RATE 1 Selects the fast measurement rate.

Selection of the fast measurement rate using the RATE 1 command will speed up the measurement portion of the scan interval; however, the measurement resolution is four digits instead of five digits. For example, a reading of +115.32 with a slow measurement rate would be +115.3 with the fast measurement rate. An Execution Error is generated if the argument is not 0 or 1 or if the instrument is scanning.

Table 4-5. Command and Query Reference (Continued)

| | |
|---|---|
| RATE? | Measurement Rate Query<br><br>Returns the measurement rate, as selected with the RATE command.<br><br>0 Measurement rate is slow.<br><br>1 Measurement rate is fast. |
| REMS | Remote without Lockout<br><br>Places the instrument in the remote mode, lights the front panel REM annunciator, and only two front panel keys are active (with special REMS functionality):<br><br>The SCAN key triggers a single scan.<br><br>The SHIFT key returns the instrument to normal front panel control.<br><br>To return the instrument to normal front panel control with a command, use the LOCS command. |
| REVIEW_CLR | Clear Review Values<br><br>Clear all minimum, maximum, and last values (all channels) in the Review array. (It is not possible to selectively clear individual entries in the Review array.) The Review clearing operation is carried out at any time, except during the measurement portion of the scan interval. Clearing the Review array also clears ALARM OUTPUTS and DIGITAL I/O lines to a logic high. |
| *RST | Reset<br><br>(See front of table.) |
| RTD_R0 | RTD Ice Point (R0)<br><br>For the indicated channel, store the numeric data as the RTD R0 ice point resistance, i.e., the resistance of the RTD at 32°F (0°C). Changing the ice point also clears the Review array and ALARM OUTPUTS and the DIGITAL I/O lines. (The 0 portion of R0 in the RTD_R0 command is the number zero.) The default value is 100.00.<br><br>RTD_R0 <channel>, <R0><br><br><channel> = 0,1,2 ... 20<br><br><R0> = 000.00 to 999.99<br><br>An Execution Error is generated if the R0 value supplied is not within the indicated range, the channel specified is invalid, the channel is defined as OFF, or measurements are active.<br><br>Example: RTD_R0 6, 124.85 [For channel 6, set the R0 ice point resistance to a value of 124.85.] |

### Table 4-5. Command and Query Reference (Continued)

| | |
|---|---|
| RTD_R0? | RTD Ice-Point (R0) Query<br><br>Returns the RTD R0 (ice-point resistance) value for the indicated channel. (The 0 portion of R0 in the RTD_R0 command is the number zero.)<br><br>RTD_R0? <channel><br><br><channel> = 0,1,2, ... 20<br><br>If the channel number is invalid, an Execution Error is generated. If a channel is defined OFF, or if no change has been made to R0 for a channel, the value "+100.00E+0" (default) is returned. |
| RWLS | Remote with Lockout<br><br>All front panel keys are disabled, and the REM annunciator is lit. Clear with the LOCS command. |

### Table 4-5. Command and Query Reference (Continued)

SCALE_MB

Set Mx+B Scaling Values

Set the M and B scaling values for the indicated channel, and display the results of the Mx+B calculation in the indicated display range. Changing the Mx+B of any channel also clears the Review array, and resets ALARM OUTPUTS and DIGITAL I/O lines.

SCALE_MB <channel>, <M_value>, <B_value>, <range>

<channel> = 0, 1, 2, ... 20

<M_value> = signed numeric quantity

<B_value> = signed numeric quantity

<range> = 1, 2, 3, ... 16

The range code for the display <range> is shown below:

| RANGE CODE | DISPLAY OFFSET VALUE | MAX B | RANGE CODE | DISPLAY OFFSET VALUE | MAX B |
|---|---|---|---|---|---|
| 1 | 0.0000 m | 9.9999E-3 | 9 | 0.0000 k | 9.9999E3 |
| 2 | 00.000 m | 99.999E-3 | 10 | 00.000 k | 99.999E3 |
| 3 | 000.00 m | 999.99E-3 | 11 | 000.00 k | 999.99E3 |
| 4 | 0000.0 m | 9999.9E-3 | 12 | 0000.0 k | 9999.9E3 |
| 5 | 0.0000 x1 | 9.9999 | 13 | 0.0000 M | 9.9999E6 |
| 6 | 00.000 x1 | 99.999 | 14 | 00.000 M | 99.999E6 |
| 7 | 000.00 x1 | 999.99 | 15 | 000.00 M | 999.99E6 |
| 8 | 0000.0 x1 | 9999.9 | 16 | 0000.0 M | 9999.9E6 |

When M=1 and B=0, there is no Mx+B scaling. The entries for M and B must be between ±0.0001E-3 and ±9999.9E+6. An Execution Error is generated by invalid entries, a channel set to OFF, if the instrument is scanning, or if the range code is too low for the selected B value. For example, the minimum display range for B=1000 is code 8. Mx+B scaling values for a channel are automatically reset to 1 (M) and 0 (B) when the function for that channel is changed. Returned measurements for a channel with Mx+B scaling has a function identifier of MX+B (when FORMAT 2 has been asserted).

Example: SCALE_MB 18,+.55555,-17.777,6 [For channel 18, M=+.55555, B=-17.777, and the display range is 00.000 x1.]

## Table 4-5. Command and Query Reference (Continued)

SCALE_MB?

Mx+B Scaling Values Query

Returns the M and B scaling values and display range for the selected channel, as entered with the SCALE_MB command.

SCALE_MB? <channel>

<channel> = 0, 1, 2, ... 20

This command returns three values. The first two are the M and B values for the channel indicated, even when M=1 and B=0 or the channel function is defined as OFF. These first two values are returned in M and B order and in scientific notation format with five digits of resolution. The third value returned indicates the Mx+B display range. The Mx+B scaling values are automatically reset to 1 (M) and 0 (B) when the function for that channel is changed.

The range code for the display <range> is shown below:

| RANGE CODE | DISPLAY OFFSET VALUE | MAX B | RANGE CODE | DISPLAY OFFSET VALUE | MAX B |
|---|---|---|---|---|---|
| 1 | 0.0000 m | 9.9999E-3 | 9 | 0.0000 k | 9.9999E3 |
| 2 | 00.000 m | 99.999E-3 | 10 | 00.000 k | 99.999E3 |
| 3 | 000.00 m | 999.99E-3 | 11 | 000.00 k | 999.99E3 |
| 4 | 0000.0 m | 9999.9E-3 | 12 | 0000.0 k | 9999.9E3 |
| 5 | 0.0000 x1 | 9.9999 | 13 | 0.0000 M | 9.9999E6 |
| 6 | 00.000 x1 | 99.999 | 14 | 00.000 M | 99.999E6 |
| 7 | 000.00 x1 | 999.99 | 15 | 000.00 M | 999.99E6 |
| 8 | 0000.0 x1 | 9999.9 | 16 | 0000.0 M | 9999.9E6 |

Example: SCALE_MB? 0 returns +1.0000E+0,-1.0000E+3,9 [For channel 0, M=1, B=-1000, and the display range is 0.0000 k.]

Table 4-5. Command and Query Reference (Continued)

| | |
|---|---|
| SCAN | Enable/Disable Scanning<br><br>This command performs the same function as pressing the SCAN key on the front panel.<br><br>SCAN 0 Disables scanning<br>SCAN 1 Enables scanning<br><br>If SCAN 0 is set during the measurement interval of the scan, the measurement portion is completed. If SCAN 0 is set during the countdown interval of the scan, the scan is immediately terminated.<br><br>If there are no configured channels (all are defined as OFF) or values other than 0 or 1 are given, an Execution Error is generated.<br><br>The MON and SCAN commands work in conjunction with the front panel controls. The Monitor and Scan functions can be enabled or disabled from either the front panel or the computer interface. The most recently specified monitor channel (from front panel or computer interface) becomes the one channel monitored.<br><br>Front panel SCAN and MON keys work only when the lockout state is "local without lockout" (see the LOCS command). |
| SCAN? | Scan Query.<br><br>Returns the scanning status, as selected with the SCAN command.<br><br>0 Scanning is disabled<br>1 Scanning is enabled<br><br>If a scan is in progress, a "1" is returned at the end of the scan. (A response delay may occur if SCAN? is sent early in a scan.) This feature allows synchronization for other commands that would not be recognized if received during a scan. For example, SCAN?;*TRG could be used to trigger a new scan after completion of the current scan, where just a *TRG command sent while a scan is in progress would be discarded. If a scan is not in progress, a "0" is returned immediately. |
| SCAN_TIME? | Time of Scan<br><br>Returns values indicating the time and date at start of last scan.<br><br>Uses the same format and order as the TIME_DATE? query. The data is returned in the following order: Hours (0-23), Minutes (0-59), Seconds (0-59), Month (1-12), Date (1-31), Year (0-99).<br><br>Example: SCAN_TIME? returns 7,56,50,7,21,94 [The start of the last scan was at 0700 hours, 56 minutes, 50 seconds, on July 21, 1994.] |
| *SRE | Service Request Enable<br><br>(See front of table.) |
| *SRE? | Service Request Enable Query<br><br>(See front of table.) |

## Table 4-5. Command and Query Reference (Continued)

***STB?**

Read Status Byte Query

(See front of table.)

---

**TEMP_CONFIG**

Temperature Configuration

Set temperature configuration using the given value. Changing the temperature configuration also clears the Review array, and ALARM OUTPUTS and DIGITAL I/O lines.

TEMP_CONFIG <value>

<value> = 0, 1, 2, 3

Selects the temperature scale (°C or °F) and enables or disables thermocouple detection. When thermocouple detection is enabled and an open thermocouple is detected, the monitor display will show "otc" and the measurement return is +009.00E+9. When thermocouple detection is disabled and an open thermocouple is detected, the monitor display will show "OL" and the measurement return is -001.00E+9. These settings affect every channel; they cannot be set for each channel individually. The command is entered when the instrument is not scanning. Select the desired <value> from the table below.

| VALUE | MEANING |
|---|---|
| 0 | OTC Disable and °C |
| 1 | OTC Disable and °F |
| 2 | OTC Enable and °C |
| 3 | OTC Enable and °F |

Example: TEMP_CONFIG 3 [Measure temperature in °F and enable "otc" detection.]

---

**TEMP_CONFIG?**

Temperature Configuration Query

Returns the status of the temperature configuration, as selected with the TEMP_CONFIG command. Returns an integer 0, 1, 2, or 3, which corresponds to the temperature configuration, as shown in the table below.

| VALUE | MEANING |
|---|---|
| 0 | OTC Disable and °C |
| 1 | OTC Disable and °F |
| 2 | OTC Enable and °C |
| 3 | OTC Enable and °F |

Example: TEMP_CONFIG? returns 2 ["otc" detection is enabled and the temperature scale is °C.]

## Table 4-5. Command and Query Reference (Continued)

| | |
|---|---|
| TIME | Set the Instrument Time.<br><br>TIME <hours>, <minutes> [,seconds]<br><hours> = 0, 1, 2, ... 23 (24-hour scale)<br><minutes> = 0, 1, 2, ... 59<br>[seconds] = 0, 1, 2, ... 59<br><br>Invalid values generate an Execution Error. The [seconds] field can be left blank, automatically entering 00.<br><br>Example: TIME 16,30,15 [Set the clock for 1600 hours (4 pm), 30 minutes, and 15 seconds.] |
| TIME_DATE? | Retrieve Time and Date<br><br>Returns comma-separated integer values for time, date, and year using the following format:<br><br>hours 0 to 23<br>minutes 0 to 59<br>seconds 0 to 59<br>month 1 to 12<br>day 1 to 31<br>year 00 to 99<br><br>The TIME command is used to set hours, minutes, and seconds.<br><br>Example: TIME_DATE? returns 2,43,12,7,21,94 [The time is 0200 hours, 43 minutes, 12 seconds, on July 21, 1994.] |
| TOTAL | Set Totalizer Count<br><br>Give the Totalizer count a new initial value.<br><br>TOTAL <t_value><br><t_value> = 0, 1, 2, ... 65535<br><br>If the value is not in the range 0 through 65,535, an Execution Error is generated. Setting the totalizer count also clears the Totalize Overflow bit in the Instrument Event Register (see Figure 4-3). Clear the Totalizer count by setting the Totalizer to zero (0).<br><br>Example: TOTAL 12000 [Set the totalizer count to 12000.] |
| TOTAL? | Totalizer Value Query<br><br>Returns the present value of the Totalizer count. Format of the value is +00.000E+3. If the Totalizer has overflowed, the value returned is +001.00E+9.<br><br>Example: TOTAL? returns 13.465E+3 [The present value of the totalizer count is 13,465.] |

## Table 4-5. Command and Query Reference (Continued)

| | |
|---|---|
| TOTAL_DBNC | Set Totalizer Debounce<br><br>Set totalizer input debounce state, which adds a delay of 1.75 ms to each transition, allowing increased accuracy from totalizer inputs from contact closures.<br><br>TOTAL_DBNC 0 — Selects debounce off.<br>TOTAL_DBNC 1 — Selects debounce on.<br><br>Use of any other value causes an Execution Error to be generated. At initial power up, totalizer debounce is disabled (set to 0). An Execution Error is generated if the totalizer debounce setting is changed when scanning while logging to the memory card is enabled. |
| TOTAL_DBNC? | Totalizer Debounce Query<br><br>Returns the totalizing input's debounce state, as selected with the TOTAL_DBNC command.<br><br>0 — Debounce is off<br>1 — Debounce is on |
| *TRG | Single-Scan Trigger<br><br>(See front of table.) |
| TRIGGER | Select Trigger Type<br><br>Select the type of scan triggering option. The use of a trigger option has the same effect as pressing the front panel SCAN key. An input for an external trigger is available at the ALARM OUTPUTS connector on the rear panel of the instrument, pins TR and (TRIGGER 1). Scanning can be enabled when a monitored channel goes into alarm (TRIGGER 2).<br><br>TRIGGER 0 — External trigger and Alarm trigger disabled<br>TRIGGER 1 — External trigger enabled<br>TRIGGER 2 — Alarm trigger enabled<br><br>TRIGGER 0 means external triggering is disabled and only normal scan interval triggering can be used. If entered during scanning and logging to the memory card, an Execution Error is generated.<br><br>TRIGGER 1 means that external triggering is enabled. An acceptable low input (-0.6 to +0.8V dc) between the pins TR and on the ALARM OUTPUTS connector on the rear panel will cause the instrument to start scanning. When the TR input returns to logic high, scanning is disabled. External trigger inputs during a scan are ignored.<br><br>TRIGGER 2 means the alarm trigger is enabled. When a channel being monitored goes into alarm, the instrument starts scanning. When the channel being monitored goes out of alarm, the instrument stops scanning.<br><br>If the trigger type given is not one of the listed values, an Execution Error is generated. |

**Table 4-5. Command and Query Reference (Continued)**

| | |
|---|---|
| TRIGGER? | Trigger Type Query<br><br>Returns an integer representing the present trigger type, as selected with the TRIGGER command.<br><br>0 External trigger and Alarm trigger disabled<br>1 External trigger enabled<br>2 Alarm trigger enabled |
| *TST? | Self Test Query<br><br>(See front of table.) |
| *WAI | Wait-to-continue<br><br>(See front of table.) |

```
10  ' HYDRALOG.BAS  Hydra Program to scan VDC, VAC, OHMS, FREQ or TEMP
20  '            - initializes RS-232 Communications between PC and Hydra
30  '            - configures a number of Hydra channels for one type
40  '              of measurement (e.g., VDC, VAC, temperature, etc.)
50  '            - scan channels 3 times, and display and record measurement
60  '              data in file "TESTDATA.PRN"
70  '
80  ' NOTE: Hydra must be set up for RS-232 communications, 9600 baud,
90  '       no parity, 8 bit data
100 '
110 KEY OFF              ' Switch keyboard event trapping off
120 '
130 ' NOTE: Error message checking is not done here - GWBasic will notify the
140 '  user and exit if there is a problem
150 '
160 ' Open Communications port with 9600 baud, no parity, 8 it data,
170 '      ignore Clear to Send, Data Set Ready, and Carrier Detect.
180 '
190 OPEN "COM2:9600,N,8,,cs0,ds0,cd0" FOR RANDOM AS #1
200 '
210 '
220 OPEN "testdata.PRN" FOR OUTPUT AS #2    ' Open data file
230 '
240 PRINT #1, "ECHO 0"                    ' Turn off command echo on Hydra
250 '
260 '--
270 ' Find out the number of channels the user wants to configure
280 ' NOTE: Channel 0 will not be used
290 '
300 NUMCHANNELS = 0
310 WHILE (NUMCHANNELS < 1) OR (NUMCHANNELS > 20)
320    INPUT "Enter the number of channels to be scanned (1-20): ", NUMCHANNELS
330 WEND
340 '
350 'Turn unused channels off
360 PRINT "(Wait...)"
370 '
380 FOR INDEX = (NUMCHANNELS + 1) TO 20
390    PRINT #1, "FUNC " + STR$(INDEX) + ",OFF"
400    GOSUB 1120
410 NEXT INDEX
420 '
430 '
440 'Configure Hydra Channels
450 ' First, initialize screen and display Hydra identification info
460 CLS
470 LOCATE 1, 25: PRINT "Sample Program for Hydra"
480 PRINT #1, "*IDN?": GOSUB 1120: LINE INPUT #1, RESULT$
490 LOCATE 2, 20: PRINT RESULT$
500 '
510 WHILE (1)
520    'Print banner line at bottom of screen
530    LOCATE 25, 1
540    PRINT "1 = VDC   2 = VAC   3 = OHMS   4 = FREQ   5 = TEMP   6 = Quit";
550    ' Get channel configurations
560    FUNC$ = "0"
570    WHILE (FUNC$ < "1") OR (FUNC$ > "6")
580        LOCATE 23, 1: INPUT "                    Selection: ", FUNC$
590    WEND
600    ' Exit and clean up if choice is "Quit"
610    IF FUNC$ = "6" THEN CLOSE 1, 2: CLS : KEY ON: END
```

**Figure 4-4. Sample Program (GWBASIC)**

```
620 '
630   ' Set up the common channel configuration string (function and range)
640   IF (FUNC$ = "1") THEN CONFIG$ = "VDC, 1"
650   IF (FUNC$ = "2") THEN CONFIG$ = "VAC, 1"
660   IF (FUNC$ = "3") THEN CONFIG$ = "OHMS, 1, 2"  ' Assuming 2-terminal channel
670   IF (FUNC$ = "4") THEN CONFIG$ = "FREQ, 1"
680   IF (FUNC$ = "1") THEN CONFIG$ = "TEMP, K"     ' Assuming K thermocouple
690 '
700   'Set up Hydra / Configure channels
710   LOCATE 23, 1: PRINT "Programming Hydra...";
720   FOR INDEX = 1 TO NUMCHANNELS
730      PRINT #1, "FUNC " + STR$(INDEX) + "," + CONFIG$
740      GOSUB 1120
750   NEXT INDEX
760 '
770   LOCATE 23, 1: PRINT "Measuring " + CONFIG$ + "                    "
780 '
790   ' Scan three times
800   FOR INDEX = 1 TO 3
810       PRINT #1, "*TRG"                       ' Start a single scan
820       GOSUB 1120                        ' Get prompt back from Hydra
830      PRINT #1, "SCAN_TIME?": GOSUB 1120
840      LINE INPUT #1, RESULT$                 ' Get scan time stamp
850      PRINT #2, RESULT$                      ' Save time stamp to data file
860      FOR CHANNELINDEX = 1 TO NUMCHANNELS          ' Get scan data
870         PRINT #1, "LAST? " + STR$(CHANNELINDEX) ' Request channel data
880           GOSUB 1120
890           INPUT #1, RESULT$
900          LOCATE CHANNELINDEX + 2, 25                  ' Get channel result
910          PRINT "Chan " + STR$(CHANNELINDEX) + ": ";
920           PRINT RESULT$                               ' Print results to screen
930          PRINT #2, RESULT$ + ",";                     ' Print results to data file
940      NEXT CHANNELINDEX
950       PRINT #2, ""                          ' End of line to data file
960   NEXT INDEX
970 WEND
980 END
990 '
1000  '
1010  '
1020  '
1030  ' CHECKRESPONSE Subroutine
1040  ' This subroutine checks the Hydra prompt after sending a command to
1050  '  Hydra, to see if an error occurred
1060  '
1070  ' The possible responses are:
1080  '       "=>(CR)(LF)"    (command successful)
1090  '       "?>(CR)(LF)"    (command syntax error)
1100  '       "!>(CR)(LF)"    (command execution error)
1110  '
1120   PROMPT$ = INPUT$(4, #1)                         ' Get prompt
1130  IF INSTR(1, PROMPT$, "=>") <> 0 THEN RETURN    'Command successful
1140  IF INSTR(1, PROMPT$, "?>") <> 0 THEN
1150     PRINT "Command Syntax Error!"
1160  ELSEIF INSTR(1, PROMPT$, "!>") <> 0 THEN
1170     PRINT "Command Execution Error!"
1180  END IF
1190  '
1200  PRINT "Program execution halted due to communications errors"
1210  END
```

**Figure 4-4. Sample Program (GWBASIC) (Cont)**

```
' HYDRALOG.BAS  Hydra Program to scan VDC, VAC, OHMS, FREQ or TEMP
'             - initializes RS-232 Communications between PC and Hydra
'             - configures a number of Hydra channels for one type
'               of measurement (e.g., VDC, VAC, temperature, etc.)
'             - scan channels 3 times, and display and record measurement
'               data in file "TESTDATA.PRN"

' NOTE: Hydra must be set up for RS-232 communications, 9600 baud,
'       no parity, 8 bit data

KEY OFF                    ' Switch keyboard event trapping off

' NOTE: Error message checking is not done here — QBasic will notify the
'  user and exit if there is a problem

' Open Communications port with 9600 baud, no parity, 8 it data,
'       ignore Clear to Send, Data Set Ready, and Carrier Detect.

OPEN "COM2:9600,N,8,,cs0,ds0,cd0" FOR RANDOM AS #1


OPEN "testdata.PRN" FOR OUTPUT AS #2    ' Open data file

PRINT #1, "ECHO 0"                     ' Turn off command echo on Hydra

'—
' Find out the number of channels the user wants to configure
' NOTE: Channel 0 will not be used

NumChannels = 0
WHILE (NumChannels < 1) OR (NumChannels > 20)
   INPUT "Enter the number of channels to be scanned (1-20): ", NumChannels
WEND

'Turn unused channels off
PRINT "(Wait...)"

FOR Index = (NumChannels + 1) TO 20
   PRINT #1, "FUNC " + STR$(Index) + ",OFF"
   GOSUB CheckResponse
NEXT Index
```

Figure 4-5. Sample Program (QBASIC)

```
'Configure Hydra Channels
' First, initialize screen and display Hydra identification info
CLS
LOCATE 1, 25: PRINT "Sample Program for Hydra"
PRINT #1, "*IDN?": GOSUB CheckResponse: LINE INPUT #1, Result$
LOCATE 2, 20: PRINT Result$

WHILE (1)
   'Print banner line at bottom of screen
   LOCATE 25, 1
   PRINT "1 = VDC   2 = VAC   3 = OHMS   4 = FREQ   5 = TEMP   6 = Quit";
   ' Get channel configurations
   Func$ = "0"
   WHILE (Func$ < "1") OR (Func$ > "6")
       LOCATE 23, 1: INPUT "                         Selection: ", Func$
   WEND
   ' Exit and clean up if choice is "Quit"
   IF Func$ = "6" THEN CLOSE 1, 2: CLS : KEY ON: END

   ' Set up the common channel configuration string (function and range)
   SELECT CASE Func$
       CASE "1"
           Config$ = "VDC, 1"
       CASE "2"
           Config$ = "VAC, 1"
       CASE "3"
          Config$ = "OHMS, 1, 2"  ' Assuming 2-terminal channel
       CASE "4"
           Config$ = "FREQ, 1"
       CASE "5"
          Config$ = "TEMP, K"     ' Assuming K thermocouple
   END SELECT

   'Set up Hydra / Configure channels
   LOCATE 23, 1: PRINT "Programming Hydra...";
   FOR Index = 1 TO NumChannels
      PRINT #1, "FUNC " + STR$(Index) + "," + Config$
      GOSUB CheckResponse
   NEXT Index

   LOCATE 23, 1: PRINT "Measuring " + Config$ + "                  "

   ' Scan three times
   FOR Index = 1 TO 3
       PRINT #1, "*TRG"                ' Start a single scan
       GOSUB CheckResponse              ' Get prompt back from Hydra
      PRINT #1, "SCAN_TIME?": GOSUB CheckResponse
       LINE INPUT #1, Result$          ' Get scan time stamp
       PRINT #2, Result$               ' Save time stamp to data file
       FOR ChannelIndex = 1 TO NumChannels        ' Get scan data
          PRINT #1, "LAST? " + STR$(ChannelIndex) ' Request channel data
           GOSUB CheckResponse
           INPUT #1, Result$                      ' Get channel result
           LOCATE ChannelIndex + 2, 25
           PRINT "Chan " + STR$(ChannelIndex) + ": ";
           PRINT Result$                          ' Print results to screen
           PRINT #2, Result$ + ",";               ' Print results to data file
       NEXT ChannelIndex
       PRINT #2, ""                    ' End of line to data file
   NEXT Index
WEND
END
```

Figure 4-5. Sample Program (QBASIC) (Cont)

```
CheckResponse:
' CHECKRESPONSE Subroutine
' This subroutine checks the Hydra prompt after sending a command to
'  Hydra, to see if an error occurred

' The possible responses are:
'      "=>(CR)(LF)"    (command successful)
'      "?>(CR)(LF)"    (command syntax error)
'      "!>(CR)(LF)"    (command execution error)

PROMPT$ = INPUT$(4, #1)                           ' Get prompt
IF INSTR(1, PROMPT$, "=>") <> 0 THEN RETURN      'Command successful
IF INSTR(1, PROMPT$, "?>") <> 0 THEN
   PRINT "Command Syntax Error!"
ELSEIF INSTR(1, PROMPT$, "!>") <> 0 THEN
   PRINT "Command Execution Error!"
END IF

PRINT "Program execution halted due to communications errors"
END
```

**Figure 4-5. Sample Program (QBASIC) (Cont)**

```
/*
 * HYDRALOG.C    Hydra Program to scan VDC, VAC, OHMS, FREQ or TEMP
 *               - initializes RS-232 Communications between PC and Hydra
 *               - configures a number of Hydra channels for one type
 *                 of measurement. (e.g., VDC, VAC, temperature, etc.)
 *               - scan channels 3 times, and display and record measurement
 *                 data on the screen and in file "testdata.prn"
 *
 * This program uses routines from the GreenLeaf Communications Library
 * (asiopen(), asiputs(), and asigets_timed()) for sending and receiving
 * information from the serial port connected to the Hydra.  We recommend
 * the use of a third-party serial communications library when developing
 * C programs to communicate with Hydra instruments over PC serial ports.
 */

/*
 * NOTE: Hydra must be set up for RS-232 communications, 1200 baud,
 *       no parity, 8 bit data
 */

#include <stdio.h>
#include <string.h>
#include <errno.h>

#include "asiports.h"            /* Greenleaf CommLib include file */

static FILE *testdata;           /* File handle for output data file */


main(argc,argv)
int argc;
char *argv[];
{
    int ret_code;                /* code returned by various GreenLeaf
                                    communications functions */

    unsigned numChannels;        /* Number of channels to be scanned */
    unsigned index;              /* counter */

    char response[30];           /* Buffer for user response */
    char sendbuff[129];          /* local buffer for transmitting to Hydra */
    char recvbuff[129];          /* local buffer for receiving from Hydra */


    /* Open and initialize COM2, the serial port the Hydra unit is attached
       to, for 1200 baud, no parity, 8 it data, and ignore DTR and CTS */

    ret_code = asiopen( COM2, (ASINOUT | BINARY | NORMALRX), 1000, 1000,
                    1200L, P_NONE, 1,8,ON,ON );
    if ( ret_code < ASSUCCESS ) {
        fprintf(stderr,"Failed to open the port, Greenleaf error: %d.\n",
                ret_code );
        exit(1);
    }

    /* send reset and unstall */
    asiputc(COM2, '\x11');
    asiputc(COM2, '\x03');
    checkResponse ();            /* Get prompt */
```

Figure 4-6. Sample Program (QuickC)

```
asiputs( COM2, "ECHO 0", -2); /* Turn off command echo on Hydra */
checkResponse();        /* Get prompt */


/* Open data file TESTDATA.PRN */
if((testdata = fopen("testdata.prn","w")) == NULL)
 {
   perror("Cannot open testdata.prn");
    exit(1);
 }

/* Find out the number of channels the user wants to configure
   NOTE: Channel 0 will not be used */

numChannels = 0;
while((numChannels < 1) || (numChannels > 20))
 {
   fprintf(stdout,"Enter the number of channels to be scanned (1-20):");
    gets(response);
   numChannels = atoi(response); /* convert ascii response to numeric */
 }

/* Turn off unused channels */
fprintf(stdout,"\nWait....\n");
for(index = numChannels + 1; index < 21; ++index)
 {
   sprintf(sendbuff,"FUNC %d, OFF",index);
   asiputs(COM2,sendbuff,-2);
    checkResponse();        /* get prompt */
 }

/* Print Header and Hydra identification header */

fprintf(stdout,"\n\nSample Program for Hydra\n");

asiputs (COM2,"*IDN?",-2);  /* Ask for Hydra identification info */
asigets_timed (COM2,recvbuff,256,-2,TICKS_PER_SECOND*2); /* Receive Hydra
                                                           identification
                                                           header */


checkResponse();  /* Get prompt */
fprintf (stdout, "%s\n\n",recvbuff);


  /*
  * Configure channels and scan until user chooses to Quit
   */

  while(1)
  {
     int func;            /* Configuration setting */
     char configStr[14];  /* channel function string */

       /*
       *  Configure Hydra Channels
        */
```

Figure 4-6. Sample Program (QuickC) (Cont)

```
/* Request channel configuration from user */
fprintf(stdout,
"1 = VDC\t\t2 = VAC\t\t3 = OHMS\t4 = FREQ\t5 = TEMP\t\t6 = Quit\n");

func = 0;
do
{
    fprintf(stdout," Selection (1-6): ");
    gets(response);
    func = atoi(response);
} while((func < 1) || (func > 6));


if(func == 6)               /* If Quit, exit program */
    break;

switch(func)
{                           /* set configuration string */
case 1:
    strcpy(configStr,"VDC,1");
    break;
case 2:
    strcpy(configStr,"VAC,1");
    break;
case 3:
    strcpy(configStr,"OHMS,1,2"); /* Assuming 2-terminal channel */
    break;
case 4:
    strcpy(configStr,"FREQ,1, 1");
    break;
case 5:
    strcpy(configStr,"TEMP, K"); /* Assuming K thermocouple */
    break;
}

/* Send configuration to Hydra */
fprintf(stdout,"Programming Hydra...\n");
for(index = 1;index <= numChannels;++index)
{
sprintf(sendbuff,"FUNC %d,%s",index,configStr);
 asiputs(COM2,sendbuff,-2);
  checkResponse();    /* get prompt */
}
```

**Figure 4-6. Sample Program (QuickC) (Cont)**

```
/*
 *  Scan and receive data
 */

fprintf(stdout,"\nMeasuring %s...\n",configStr);

for(index=0;index < 3;++index)
{                               /* scan three times */
    unsigned chanIndex; /* Channel counter */

    asiputs(COM2,"*TRG",-2); /* trigger scan */
    checkResponse();    /* get prompt */

    asiputs(COM2,"SCAN_TIME?",-2); /* request time stamp for scan */

                                /* receive time stamp for scan, and write to
                                data file */
        asigets_timed(COM2,recvbuff,256,-2,TICKS_PER_SECOND*30);
        checkResponse();   /* get prompt */
        fprintf(testdata,"%s\n",recvbuff);

 for(chanIndex = 1; chanIndex <= numChannels; ++chanIndex)
  {                     /* get value scanned for each channel */
    sprintf(sendbuff,"LAST? %d",chanIndex);
    asiputs(COM2,sendbuff,-2); /* request value for channel */

                                /* receive value for channel and write to
                                screen and data file */
        asigets_timed(COM2,recvbuff,256,-2,TICKS_PER_SECOND*30);
        checkResponse(); /* get prompt */
        fprintf(stdout,"Chan %d: %s, ",chanIndex,recvbuff);
     fprintf(testdata,"%s,",recvbuff);
    }
   fprintf(stdout,"\n");
   fprintf(testdata,"\n");
 }
fprintf(stdout,"\n");
fprintf(testdata,"\n");
}

fclose(testdata);
 exit(0);
}
```

Figure 4-6. Sample Program (QuickC) (Cont)

```
/*
 * This function checks the Hydra prompt after sending a command to Hydra,
 *  to see if an error occurred.
 *
 *  Possible responses are:
 *      "=>(CR)(LF)"      (Command successful)
 *      "?>(CR)(LF)"      (Command syntax error)
 *      "!>(CR)(LF)"      (Command execution error)
 */

static int checkResponse()
{
    char response[129];

                                /* Gets string from Hydra - asigets_timed
                                   gets characters from the receive buffer,
                                   and strips the (CR)(LF) characters from
                                   the end before placing them in the
                                   "response" buffer */
    asigets_timed(COM2,response,128,-2,TICKS_PER_SECOND*2);

    /* check to see if the command worked correctly */
    if(strcmp(response,"=>") == 0)
        return 0;               /* command executed without error */

    if(strcmp(response,"?>") == 0)
        fprintf(stderr,"Command Syntax Error!\n");
    else
    {
        if(strcmp(response,"!>") == 0)
            fprintf(stderr,"Command Execution Error!\n");
    }


    fprintf(stderr,"\nProgram execution halted due to communications errors\n");
    fclose(testdata);
    exit(1);
}
```

Figure 4-6. Sample Program (QuickC) (Cont)